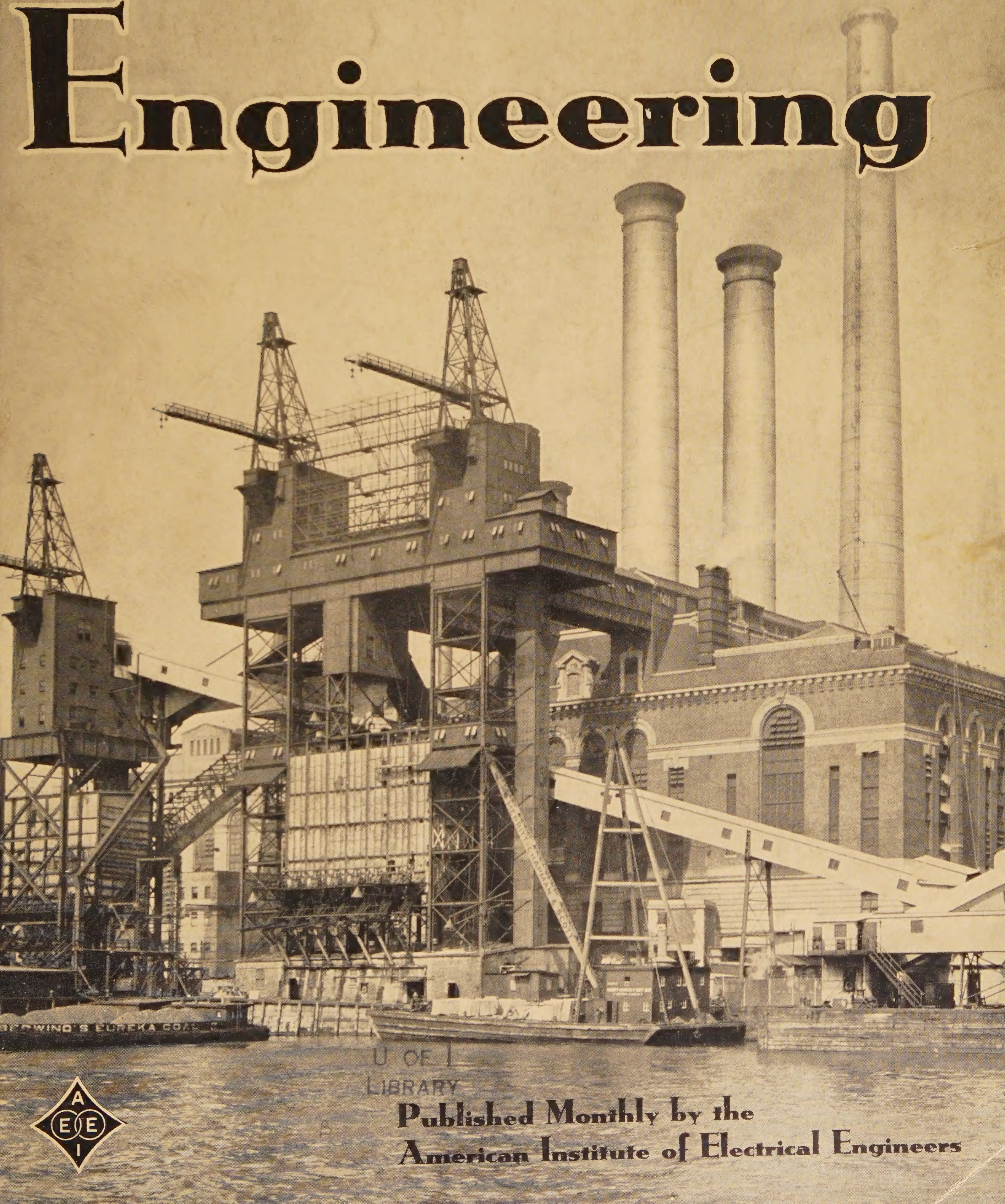
Electrical Engineering

January
1939



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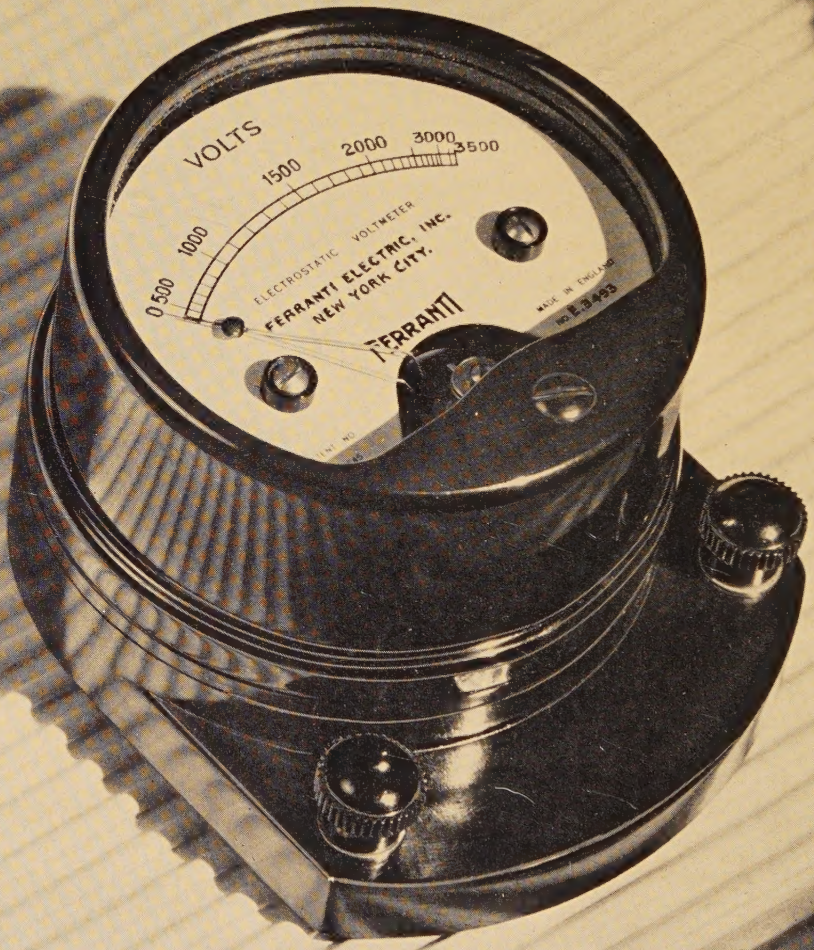

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Electrical Engineering

Registered U. S. Patent Office

for January 1939—

The Cover: Waterside Station of the Consolidated Edison Company of New York, where winter conventioners may see two recently installed high-pressure "topping" turbogenerator units

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High Lights

Engineering Education. "Professional courses should train the student to think, to analyze, and to develop his creative imagination by practice in design," says the dean of the engineering school of an eastern university, who adds: "Unless they do this they are vocational rather than professional in character" (*pages 16–18*). An educational authority in industry says that industry needs both the highly professional education that is necessary to the development of new products and methods, and the more diversified preparation that is vital to operation and management (*pages 19–22*).

Insulation Research. Outstanding characteristic of the work of the past year in dielectric research is the number of new synthetic insulating materials that have appeared. A summary of the year's progress reveals fewer noteworthy developments in applications of new knowledge to the problems of insulation, but basic research in chemistry and physics has continued (*pages 23–31*). This trend also was evident in the 22 papers presented at the recent annual meeting of the Conference on Electrical Insulation of National Research Council (*pages 40–4*).

Technical and Social Progress, and Management. The increasing complexities of modern life undoubtedly require a continually increasing degree and quality of group management. At the same time, as individuals or groups grow in their ability, the controls imposed on them must be relaxed if they are to accept and discharge responsibility. The greatest of all management problems today, according to the head of a leading engineering college, is to determine the most advantageous balance between these two principles (*pages 12–15*).

Current-Limiting Fuse. A power fuse that is intended to limit the peak short-circuit current to a fraction of that which is available in the circuit has been produced by winding fusible conductors on a supporting core and embedding this in a granular interrupting medium. The protected apparatus may then be of lower short-time current rating than might otherwise be necessary, with resultant economy (*Transactions pages 11–18*).

Winter Convention. More than 70 technical papers are scheduled for presentation at sessions of the AIEE winter convention, which will be held at New York, N. Y., January 23–27, 1939. Other convention attractions include a general session addressed by a noted economist, presentation of the 1938 Edison Medal to a past president of the Institute, the annual smoker and dinner-dance, and a variety of inspection trips (*pages 32–5*).

Potential Devices. Potential for the operation of relays and other applications may be supplied more economically from high-voltage lines by coupling-capacitor potential devices than by transformers. A clear understanding of the inherent limitations of these devices may aid in recognizing their possibilities and prevent use outside the proper field of application (*Transactions pages 1–10*).

Electrical Porcelain. With the advent of electricity, porcelain, one of the oldest industrial products, assumed a new importance. For those who have not had the opportunity to inspect a porcelain-manufacturing plant, a verbal and pictorial "inspection trip" through a modern electrical-porcelain factory may be of interest (*pages 7–11*).

Utility Engineering and Capital. To determine how capital should be used to the best advantage, is essentially an engineering problem, the correct answer to which is fundamental to the whole economic life of the nation, according to a prominent utility executive who discussed the subject at a recent AIEE Section meeting (*pages 3–6*).

Bushing Characteristics. Terminal bushings for high-voltage power transformers are subjected to various electrical tests to determine their fitness for service. A paper in this issue discusses the electrical performance of bushings and the relation of factory and developmental tests to the requirements of service (*Transactions pages 27–34*).

Traveling Waves. Switching operations on transmission lines may initiate surges which may be calculated as traveling waves and their successive reflections. Three methods for calculating switching transients are illustrated in a paper in this issue so as to allow a comparison of their relative merits (*Transactions pages 18–27*).

New Section and Branch. Among actions taken at a recent meeting of the AIEE executive committee were granting authority for organization of the San Diego Section and authorization for the establishment of a Student Branch at New Mexico State College of Agriculture and Mechanic Arts (*page 38*).

Letters to the Editor. Some of the comments received on R. E. Doherty's article "The Paradox of Social Progress" are included in this month's "Letters" section; other subjects discussed include supervisory control, and ferroresonance (*pages 46–50*).

Miami Meeting. Farthest south of the general meetings of the AIEE was the recent Southern District meeting held in Miami, Fla. The annual Southern District student conference was held concurrently. Registration totaled 258 members and guests (*pages 36–37*).

Invention Forum. A brief report of American Engineering Council's second forum, at which social and technical invention were discussed, summarizes the principal addresses that were presented (*pages 45–6*).

Coming Soon. Among special articles and technical papers now undergoing preparation for early publication are: an article by R. E. Flanders on the balancing of incentive and security; an article by T. C. Johnson on engineering opportunities in electrical manufacturing; a paper by C. F. Dalziel (A'33) on static power limits of synchronous machines; a paper by R. W. Ager (A'24) on an application of deceleration test methods to the determination of induction-motor performance; a paper by F. O. McMillan (F'32) on polarity limits of the sphere gap; a paper by A. C. Norwine on devices for controlling amplitude characteristics of telephonic signals; a paper by G. R. Shuck (M'20) on a variable-register-ratio watt-hour meter; and a paper by G. S. Smith (M'26) on the use of a bismuth-bridge magnetic fluxmeter for a-c fields.

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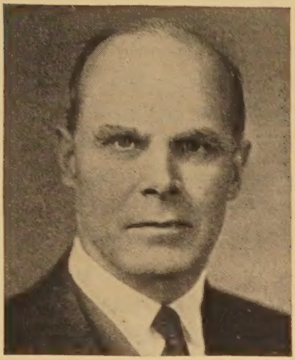
Utility Engineering and Capital

A review of the present situation in which the electric-utility industry finds itself, with particular reference to the indissoluble relationship between engineering and capital, by an outstanding student of the industry



By C. W. KELLOGG
MEMBER AIEE

A DISCUSSION of the general public-utility situation seems best approached from a consideration of the relation between engineering and capital—a relationship that is honored by time. Capital is that part of the product of human labor which the producer either does not need in order to live, or which, through self-denial, he has deliberately refrained from using to live. Capital can be transformed into the tools and machinery for producing more capital and employing more labor. The forms capital takes, like houses, factories, highways, railroads, utilities, and other items too numerous to mention, are the very basis of the comforts of life and the way of living and the going concern which we call civilization. Capital in the abstract is one of man's greatest discoveries. It is as marvellous a thing as electricity in the way it can be transmuted from one form to another. It is even more effective than electricity in the fact that it can be stored without loss—something we have not learned to do with electricity. What a revolutionary effect would be produced in the electric-service business if electricity could be stored as effectively as gas or water!

No one can be expected to exert the effort and self-denial required to accumulate capital without some incentive. That incentive, under our American system, is the right to own and possess the capital so accumulated and to be able to earn a return on it either from using it oneself or from loaning it to others. The amount one can earn on capital depends, if he uses it himself, upon his energy and ingenuity, or, if he loans it out to others, upon the going value of capital. This going value is dependent upon the supply of capital and the demand for it in the community in question. There are other unavoidable charges against capital, consisting of the loss in use, generally called depreciation, and the cost of protecting it, which appears in the form of taxes and insurance. All these charges are, as a rule, accurately determinable from the conditions surrounding any given situation.

The function of the engineer with respect to capital is clear and definite and the two are indissoluble. From the moment a given amount of capital has been created, the question at once arises, for the owner thereof, as to the form into which it shall be transformed so as to be sufficiently useful to assure to the owner a return that will pay at least the fixed charges on it, and to serve to employ labor and purchase commodities for the general welfare.

In our modern civilization the major part of the liquid capital created each year has gone into the plant required to carry on industry, to transport its product to market or to serve the daily wants of the people and of industry. Immediately there arises the need for engineering study and advice on how to use this capital, for it is essentially an engineering problem to determine how capital should be used to the best advantage. The correct answer to this question is fundamental to our whole economic life as a nation. Finding the right answer includes not only the best design and most economical construction of the new plant itself, but also the study of every detail—markets, raw materials, operating costs, and the like—which will go to make the new plant a success or failure in the matter of earning the fixed charges on that new plant, thus not only furnishing labor to those in need of employment, but also conserving the capital from destruction by being improvidently laid out.

The more complicated our plant becomes, the more difficult and intricate become the problems of plant design and of the estimates of operating results to be expected. This responsibility rests upon the shoulders of the engineer, and the responsibility is a heavy one for upon the success

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An address delivered at a meeting of the AIEE New York Section, December 13, 1938.

C. W. KELLOGG is chairman of the board of Engineers Public Service Company, New York, N. Y., and has been president of the Edison Electric Institute since 1936. He was born in Philadelphia, Pa., in 1880, and received the degrees of bachelor of science (1902) and master of science (1903) from Massachusetts Institute of Technology. He has been engaged in public-utility work throughout his entire professional career serving successively as: manager, Edison Electric Company, Brockton, Mass., 1904–05; manager, El Paso (Texas) Electric Railway Company, 1905–14; manager, Eastern Texas Electric Company, 1911–14; manager, Mississippi River Power Company, Keokuk, Iowa, 1914–19; district manager, Stone and Webster, Inc., 1916–19. From 1919 to 1925 he was engaged at the Boston, Mass., offices of Stone and Webster. In 1925, he was made president of the newly organized Engineers Public Service Company, New York, N. Y., and became chairman of the board in 1933.

with which it is discharged depends the integrity of our plant investment and, therefore, the very foundations of our economic structure. This responsibility is a personal one to the millions of thrifty citizens who tacitly depend upon the engineer to see that their savings (the result of the sweat of their brow and the self-denial of their character) are not wasted or dissipated in ill-conceived schemes. The reason it is such a social sin to waste capital is that it is saved-up human labor, and the glory of the engineering profession is that it has always been dedicated to the conservation of capital by using it skillfully for the most effective development of our natural resources.

The great electric-utility business is definitely founded on engineering. As a business it is just as dependent as any other business on public relations, sales promotion, collections, accounting, and other factors, and much more dependent than most businesses on capital financing, being about the most capital-greedy industry in existence. All these parts of the superstructure of business, however, must rest on the integrity, dependability, and economy of the service which the engineer alone has originated and developed.

How many, in passing in and out of Washington, D. C., have paused to read the words cut into the stone over the portals of the Union Station? Written nearly a quarter of a century ago by one of the greatest masters of epigram of our times, they still are fresh and full of meaning. Here is what they say about the thing we work with and for:

Electricity
Carrier of Light and Power,
Devourer of Time and Space,
Bearer of Human Speech over Land and Sea,
Greatest Servant of Man—Itself Unknown.

What an arresting thought, that man's greatest servant is an unknown thing! We know not what it is, but only what it does. Our engineering experience with electricity comes down to finding what it will do under a given set of conditions. After all, however, what it does is what makes electricity man's greatest servant, so that this knowledge is more useful and practical than the other. Therefore, we should be as content as engineers (who are always seeking for more knowledge) can be.

If electricity was man's greatest servant a quarter of a century ago, how much more is it so today! In the intervening period, in the United States, electric generating capacity has increased about sixfold; energy output has increased ninefold and the number of customers has grown by about 22,000,000. The average home today uses over three times as much electricity as it did in 1913, and the growth of this average home usage continues unabated month by month to this day. In fact, by all the tests of present size and diffusion among the people, the use of electricity a quarter of a century ago was a pitifully small thing.

While my own specialized knowledge is in the electric light and power business, it is only fair to state that during the last quarter century the great Bell Telephone System has made as striking progress as have the electric companies—in their great service of bearing human speech over land and sea. Figures furnished by the Bell System show striking achievements during the period in question. The number of telephone stations from 1913 to 1938 increased from 5,000,000 to 15,750,000. In the matter of long-distance telephony, Denver, Colo., was about as far as could be reached from New York City in 1913, but at the present time 37,000,000 telephones can be reached by long distance in all parts of the globe. This figure is 93 per cent of all the telephones in the world, located in 73 countries. They include all countries having over 100,000 telephones, except Russia and New Zealand. During this same quarter century the miles of interstate toll lines have increased from 519,000 to 6,790,000, and the number of toll messages from 8,000,000 to 54,000,000, while the average time of connection has been reduced from 6 minutes to $1^3/_4$ minutes.

I would not give the impression that the electrical development of the United States is completed. The field is nowhere near exhausted, and we still have far to go. The industries where stagnation has set in are those where engineering development and invention have largely ceased, and this is not true of the electric-utility business. We must not forget that the wonderful progress of the electric industry in the past has rested both upon engineering and upon the fact that in that industry capital could get a fair rate of hire and could look with reasonable hope for reward for risks assumed. If and when these reasonable expectations should become doubtful, the blighting effect will be on the investor, the engineer, and the public served.

The vast growth in the utilization of electricity in the last 25 years has involved an integration of many conflicting forces. For example, at the beginning of that period, the electric companies paid out $5 in taxes for each $100 they took in, while today they pay out in taxes over $16 for each $100 received. In New York City, the comparable tax figures for the electric companies are $7 in 1913 and $21 in 1938. Similarly, the average weekly cost for labor per employee in the electric industry is $2^1/_2$ times as great today as it was twenty-five years ago ("Road Maps of Industry," Number 148, National Industrial Conference Board, October 28, 1938). The general level of wholesale prices of commodities has risen 15 per cent since 1913.

These are high hurdles to jump, yet in spite of them the average cost of a kilowatt-hour of electricity in the home is today down to slightly less than one-half the average of 1913. This is no mean accomplishment for the great servant, for naturally unit cost enters as a very definite element in the economic value of any service. Thus, while the unit cost of the human service the utilities had to buy to operate their business *increased* $2^1/_2$ times, the unit price of the services of the "unknown" servant in the home was cut in two.

For this great accomplishment in the public service the credit goes partly to the engineer and partly to the salesman; and like any ideal partnership, neither could have been completely successful without the other. The contribution of the engineer was to reduce the amount of fuel required to produce a kilowatt-hour by 68 per cent during our "test period" and to make substantial reductions in the cost of the equipment to generate and use electricity. That of the salesman (reinforced by the basic work of the manufacturers and the rate engineers) was to increase the use of electricity in the average home threefold during the period.

If I have appeared to emphasize what has been done for the householder during the last quarter century, it is merely because he is the most numerous, comprising as he does about 85 per cent of the electric customers. The accomplishments with respect to power in industry have been equally notable. The increase since 1913 from 3.15 to 6.3 in the horsepower used per man in industry has been due principally to the convenience and economy of supplying power to machinery electrically—both engineering accomplishments of the first order. Foreign visitors to the United States have attributed our industrial supremacy as a nation largely to the extent to which mechanical power is used in manufacturing. Also, it should be noted that the economy in the manufacture of electric energy (which results from the fact that 60 per cent of the total electric energy sold is used by manufacturing and transportation) helps very materially with the cost to the householder.

Nothing could illustrate more clearly the indissoluble union between engineering and economics than the marvelous history of electrical development during the last quarter of a century which I have outlined so briefly, for good engineering must lead to practical results. I recall in my student days that it was frequently called to our attention that any fool could get together a set of levers and gears and cams to do almost anything, but that the true engineering genius was he who could cause a difficult physical feat to be performed simply.

This question of economic practicality comes sharply to the fore in connection with some of the governmental electric-power projects of recent years. The people have been so stirred up by propaganda about a force whose mystery seems to give it powers of performing all miracles, even economic ones, that in some cases practical values seem to have been overlooked. For example, just because the growth of use of electric service has been rapid, does not mean that every power development will be an economic success, even if no apparent market exists to absorb its output. Merely because water is a gift of nature that flows downhill without apparent cost, does not make every hydroelectric project *ipso facto* sound economically; it might be cheaper to produce power from fuel. The fact that electricity can be transmitted for long distances, with relatively small losses in energy, does not mean that in any given case it will pay to do so, unless an economic saving can be shown to result from the transmission in question.

Another common economic error about electricity arises from a failure to realize the inherent nature of the business. I am sure if the facts were more generally understood, the public reaction would be different on the power subject. The electric-utility business requires about six dollars invested in plant to produce one dollar of gross revenue. From this simple but inescapable ratio flow important consequences for the business. From this ratio it follows that the raising of capital is one of the cornerstones of the business. The average industry requires only about 73 cents of capital per dollar of annual output—about one-eighth as much as the electric-utility industry. For hydroelectric properties this ratio between capital investment and annual gross earnings is likely to be about 10 to 1, or about 13 times as great as for average industry.

Anything that affects capital is also bound up with credit. The electric utilities, though they are conceived and operated along engineering lines, must also conform to the laws of the market place, if they are to raise the capital needed for the erection of their physical properties. These laws are not legislative enactments; they are the principles embodying the experience which mankind has developed over many centuries of economic history. The utilities were obliged not only to raise adequate capital, but they also wanted to get that capital as cheaply as possible—for another of the inevitable consequences of our capital-to-earnings ratio is that fixed charges on investment comprise on the average five-eighths of the cost of furnishing electric service to the customers, and over 90 per cent of the cost of hydroelectric power furnished wholesale. Hence the cost of capital is of preponderant importance in the cost of rendering electric service. The cheapest cost money is that raised by the sale of bonds, but here again the law of the market place steps in to fix a limitation. Bonds to raise this cheap money are salable at a price to produce money cheaply only if secured by about an equal amount of some other money. So there arise at once the two very practical questions of who is going to put up that other money and of how he is going to be persuaded to do so.

In the United States this problem has been worked out over the years by the method of state regulation. Stated very briefly, the state recognized to begin with the six-to-one capital ratio mentioned. It realized that from this basic ratio flows another consequence: In order to prevent waste of capital, the purveyor of this unknown force must be alone in the field; but he may continue to be alone only so long as he does a good job. The state said further: "We will allow you to charge rates for your service which will yield a rate of return on your investment such that investors will be induced to continue to put up the money needed to build the additional plant required by the growth of your service." Relying on this regulatory system, built up over the years, the people who were willing to take a greater risk in hope of a correspondingly greater reward, put their money into the stocks of utilities in amounts sufficient adequately to secure the bonds. In this way, there has been built up the present very satisfactory ratio of bonds to total capital in the electric-utility business.

From their own point of view, engineers have always been limited in the plans they could carry out by their ability to convince someone that these plans were economically sound, and by their ability, based upon their showing, to get the investing public to agree with them sufficiently to put its hard-earned savings into the project. All engineers know of many a great engineering project they would have liked to put through if only the money could have been raised to pay for it.

Then came the New Deal. To many engineers it may have seemed at first like a dream come true—like the answer to the engineer's prayer—to have unlimited billions of taxpayers' money, or other billions borrowed on the expectation of payments to be collected in future from taxpayers (some of whom may not yet be even born) to spend *ad libitum* on all sorts of projects, without having to convince some hard-headed investment banker, or some equally obdurate investor, that the projects would pay. In case any taxpayer whose money had been put into these projects should object, he could be stilled by incantations on the general welfare or by bookkeeping methods that appear to show a profit where none exists.

I said this all seemed like a dream come true, but I wonder if it is not more like a mirage.

Have we as a nation yet counted the cost of what might be called "political engineering?" Does the public realize yet that the estimated deficit in the Federal Budget for the one fiscal year 1939—*not the expenditures but the deficit*—exceeds by $133,000,000 the total aggregate expenditures of the Federal Government during the first 76 years of our national life (1789 to 1864, inclusive)? The deficit for two months in modern times (July and August 1938) is $40,000,000 greater than the annual average Federal expenditure for the period from 1900 to 1913 (National Industrial Conference Board release, November 7, 1938). It would be tragic enough if the capital wrung from the people in taxes in recent years had been wastefully or unwisely spent, but the money represented by our 40-billion-dollar national debt constitutes a prior claim on the future labors of our people, which will have to be met from those labors before spare capital for future needs can be forthcoming.

I am inclined to believe that the engineer owes a duty to his country to point out the economic fallacies where they exist in any engineering or construction projects his country undertakes. No one knows better than he the dire consequences of engineering development divorced from economics; no one realizes more clearly than he that costs go on and costs exist whether or not some government agent says they do. The historic episode of King Canute was perhaps the first on record where government agents claimed that if a prohibition was placed on the tide rising, it would not rise. What we need today is another King Canute, to show his faithful subjects that the laws of nature go on operating, regardless of statute laws and that the wise government is that one which conforms to natural law and fact, rather than trying to oppose them or pretend they do not exist.

No one more than engineers should be able to point out the extreme distortion represented by the Government furor about electric power in recent years. Can it be that the public authorities do not realize that electricity forms but $1^1/_2$ per cent of the average family budget and that it forms but about $1^1/_2$ per cent of the costs of production for the average manufacturing business? Is it sane or sound to spend $1,651,000,000 of the people's money, as the Government is planning to do, on something that has such a relatively small economic importance? Is it wise (even assuming that otherwise the $1^1/_2$-per cent item is considered of such transcendent public importance) to choose for the public welfare a form of activity which requires more capital than almost any other for its development?

Let me develop this last point somewhat more in detail. The bill for electricity for the year 1938 in the 22,939,020 farms and other homes of the nation which used it was $808,000,000, or an average of about $9^1/_2$ cents per day per home. This business required, on the six-to-one ratio mentioned, the use of an investment of at least $4,848,000,000, probably nearer $5,500,000,000 since residence service requires a somewhat larger proportion of plant than the average of the electric business. This is an enormous amount of capital to tie up for such a small item in the family budget.

By way of contrast, I find from the Statistical Abstract of the United States that the people spend about $2,500,000,000 annually on the aggregate of such items as candy and ice cream, soft drinks and patent medicines, soap, chewing gum, cosmetics, and cigarettes. An analysis of the balance sheets of typical companies manufacturing each of such articles indicates that the capital required to produce them is about $700,000,000. Stated briefly, the home electric bill averages about one-third as much as the miscellaneous items I have mentioned and yet takes about seven times as much capital to produce. One wonders whether the taxpayers' money could not be more effectively conserved by a free handout of items that require so little capital, rather than by selecting as the basis for largess such a relatively great capital user as electricity. This is especially important, since capital raised by taxes is taken by force from the people.

In closing, I summarize what I have said herein before:

1. Capital and electricity are two of man's greatest discoveries and most useful servants.
2. The supply of electricity to the people requires a disproportionately large use of capital per unit compared with most other commodities or services.
3. The essential function of the engineer in the body politic is the conservation of its capital for the most efficient use of natural resources. This is a heavy responsibility since wasteful use of capital in one direction reduces by that much the free capital available for other necessary development.
4. Conservation of capital goes to the root of our economic situation as a nation, both because the huge national debt represents a mortgage on future capital production and because, in our modern world, labor cannot be usefully employed until capital has first furnished it the plant and tools with which to work.
5. The production of capital will be greatly retarded unless the self-denying citizen has the hope of getting a fair wage for the fruit of his self-denial.

As electrical engineers and citizens, therefore, we should make every effort to see that the public understands the indissoluble relationship between electric service and capital. The realization of this should lead to a more sympathetic attitude toward the millions of frugal citizens whose savings are devoted to the electric service of the nation. Instead of regarding them as "princes of privilege," "taking toll of the people," we shall see that they are in reality joint servants with the engineers, in making available so widely to the people, the tireless labors of the "Greatest Servant of Man."

Manufacture of Electrical Porcelain

By R. L. WHITNEY
MEMBER AIEE

An "inspection trip" through the electrical-porcelain plant of the Westinghouse Electric and Manufacturing Company at Derry, Pa.

MANUFACTURE of porcelain is one of the oldest industrial arts. With the advent of electricity, its properties as an insulator added another and very important function to a list that ran the gamut from tea cups to decorative tiles. Today there are few people indeed in the United States who do not depend in some measure on electrical porcelain for the very necessities of life. Electrical porcelain has become important in the manufacture of electrical equipment and is universally used for insulating electrical circuits of both high and low voltage. The history of high-voltage transmission and distribution is in a large measure the history of the development and economical manufacture of adequate porcelain.

In the Derry plant thousands of various sizes, shapes, and types of porcelain are produced for use in electrical apparatus and by the electrical trade at large. The processes employed here are typical of those used in other electrical-porcelain plants.

Preparation of Raw Material

Major raw materials are four in number: flint, feldspar, china clay, and ball clay; all are obtained from domestic sources (figure 1). These four dry raw materials are delivered to storage rooms directly from the railroad cars in which they are shipped, the flint, feldspar, and china clay finely pulverized and the ball clay in typical small balls or lumps.

The first step in the production of fine porcelain is the preparation or compounding of a batch or "mix" of "slip," a suspension of exact proportions of each of the raw materials in a proper amount of water. From the storage bins, the raw materials are delivered to overhead hopper-bottom bins. Under these bins is a track on which workmen can move a weighing car. The proportion of each raw material in a batch is determined by weight, and the weighing car is equipped with an accurate scale for that purpose. As each material is weighed, the weighing car dumps it on a bucket conveyor that delivers it to a blunger.

The blunger is a large circular tank containing the exact amount of water required by the batch, and is equipped with power-driven paddles to agitate the various ingredients of the batch. Agitation is continued until the specific gravity of the slip has reached a required point indicating complete suspension of all the dry ingredients in the water.

The slip or raw porcelain is drained from the blunger by gravity over a jig table through 140-mesh screens (figure 2) then flows over a magnetic separator to a pump that transports the slip to a storage cistern. Continual agitation of the slip in the cistern prevents the suspended solids from settling until the slip is required in the plant manufacturing process.

At various points in the plant, located conveniently to the final forming operations, are conventional filter presses. Slip is pumped from the storage cisterns, as it is required, to these filter presses. Here the excess water is removed, leaving the clay in the form of round cakes containing approximately 25 per cent water, thoroughly plastic and ready for processing (figure 3). Up to this point, no distinction is made between clay to be used for wet- or dry-process ware.

Wet-Process Insulators

That portion of the clay to be used for high-voltage wet-process ware is taken from the filter presses to one of several kneading or pugging mills. For the simpler pieces, this pugging is done in a series of two or three mills in which the filter cakes are cut by flat knives inclined so as to force the mass of clay through the mill and out of a nozzle at the bottom in a continuous cylinder. The clay cylinder is cut with a piano wire into easily handled lengths and fed to each succeeding mill until it reaches the final pugging operation, where the cylinders are cut to exact lengths for a particular forming operation (figure 4). The function of this pugging operation is to cut the filter cakes and knead them together, so that there may be no vestige of lamination in the final cylinder of clay, and to remove internal stresses in the clay itself, so that it will flow properly in the forming operations. Intricate hot-press pieces, and particularly the larger turned pieces, are formed from clay that has been pugged in a special mill.

In the hot-press department, pugged clay is delivered to workmen at the presses in blanks or cylinders of proper volume so that the forming operation on a line insulator may be completed with a minimum of waste or scrap. Workmen at the press knead the clay blanks to reduce further any possible internal stress, and to form the clay so that it will completely fill a plaster-of-paris mold (figure 5). These molds have cavities shaped so as to

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Prepared especially for ELECTRICAL ENGINEERING.

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form accurately the outside surface of a pin or suspension insulator. The molds and clay are delivered immediately to a power press. The press grips the outside of the mold, and a vertically reciprocating, horizontally rotating steel tool heated by a gas flame completes the forming of the inside of the insulator. Heat is used on the tool to generate steam from the moisture in the surface of the clay, thus lubricating the tool and preventing sticking.

The molds with the completely formed insulators are placed in a release dryer, where temperature and humidity are controlled. Moisture is withdrawn from the clay by absorption into the mold and by evaporation from the exposed surface of the clay. This withdrawal of moisture causes a volumetric shrinkage of the clay and permits its eventual withdrawal from the mold. After release from the mold, subsequent mechanical trimming (figure 6) and sponging of the insulator produce a smooth, even surface

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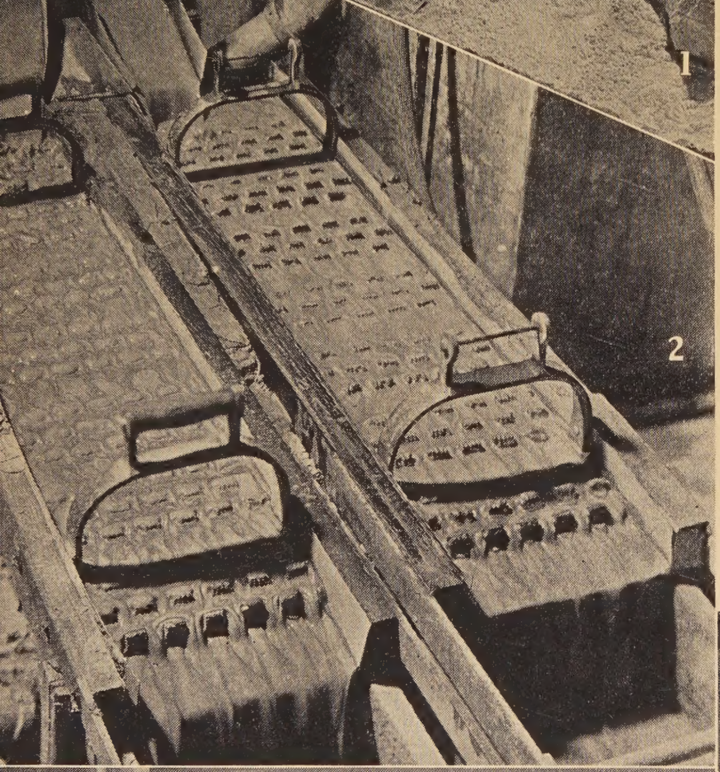
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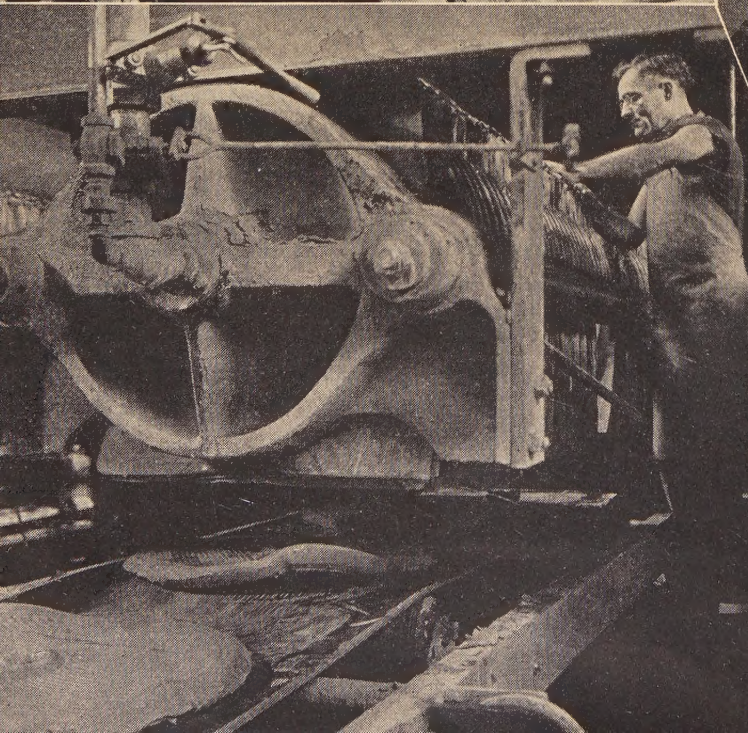
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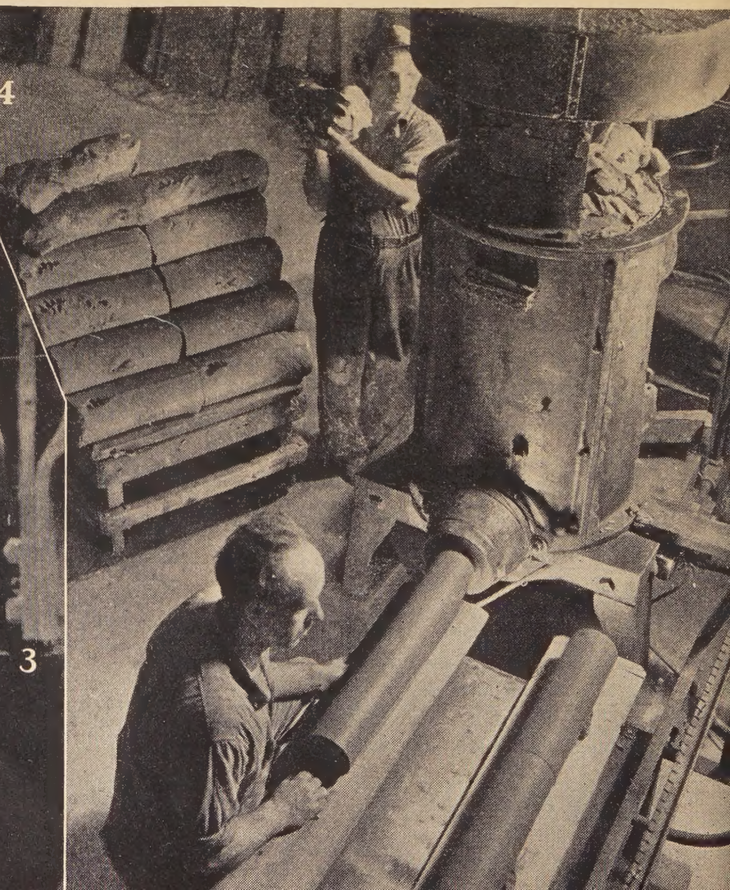
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Figure 1. Feldspar, one of the materials used in electrical porcelain, undergoing inspection

Figure 2. Impurities are removed from liquid clay by shaker screens, with no screens coarser than 140 mesh

Figure 3. Clay pancakes are created from liquid clay by a battery of filter presses which squeeze out excess water and leave remaining solids adhering to the special canvas filter. Approximately 68 per cent of the water is eliminated in this process through which pass both wet- and dry-press mix

Figure 4. A series of knives in each of these pug mills shreds the clay into strips to eliminate laminations. The clay is squeezed out in cylinders which are cut to the desired lengths by piano wires stretched across the frame at the lower right

and accurate size and shape. Final drying in a series of controlled dryers leaves the unfired insulator "bone dry" throughout and ready for glazing.

Glazing

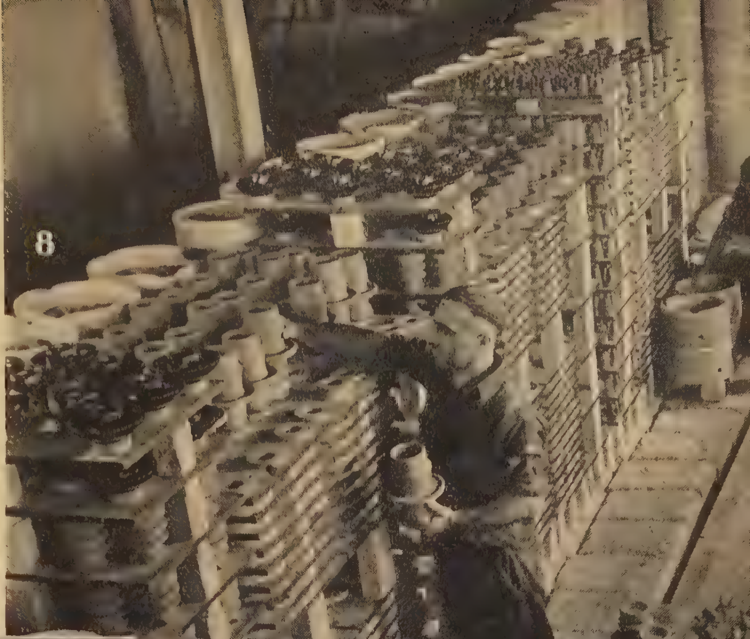
At the glazing table, the completely formed insulators receive a coating which will mature in the kiln as a properly fitted covering of colored glass. The glaze is applied by dipping the insulator into a water suspension of glass-

Figure 5. Hot pressing a high-voltage pin-type insulator. Plastic clay is kneaded by the workman in the background to eliminate possible internal stress. A talc-treated conical mold holds the clay for the powerful press which shapes the piece. A special steel tool spinning on a vertical shaft carves the shape of the insulator during the same operation

Figure 6. Insulators are turned to exact dimensions on a lathe. The operator follows a template in forming the final contours

Figure 7. Here insulators are being hand-dipped in glaze by the man in the foreground. Next the heads and pin holes are sand banded

Figure 8. The glazed pieces are stacked on long lines of shelf cars for the trip through the kiln for final firing. Carborundum slabs separate the layers of ware. Those cars in the upper right employ "saggers," rough ceramic caissons, which protect the ware from flames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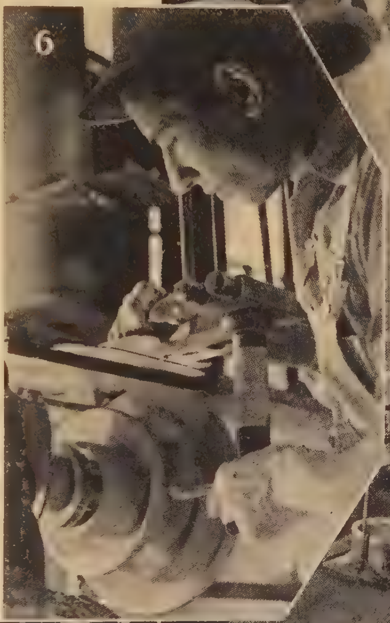
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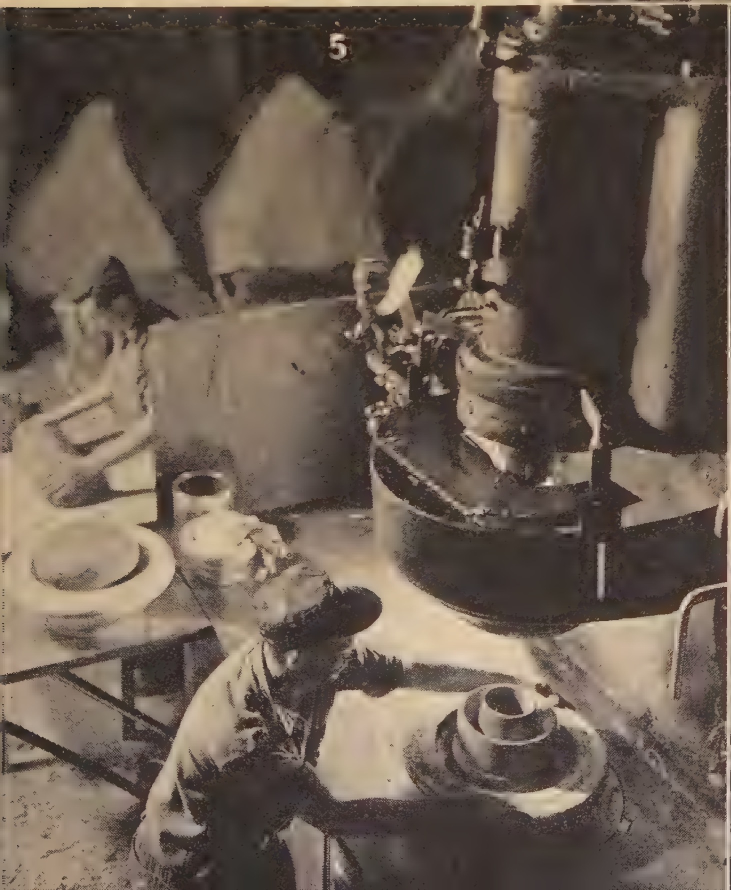
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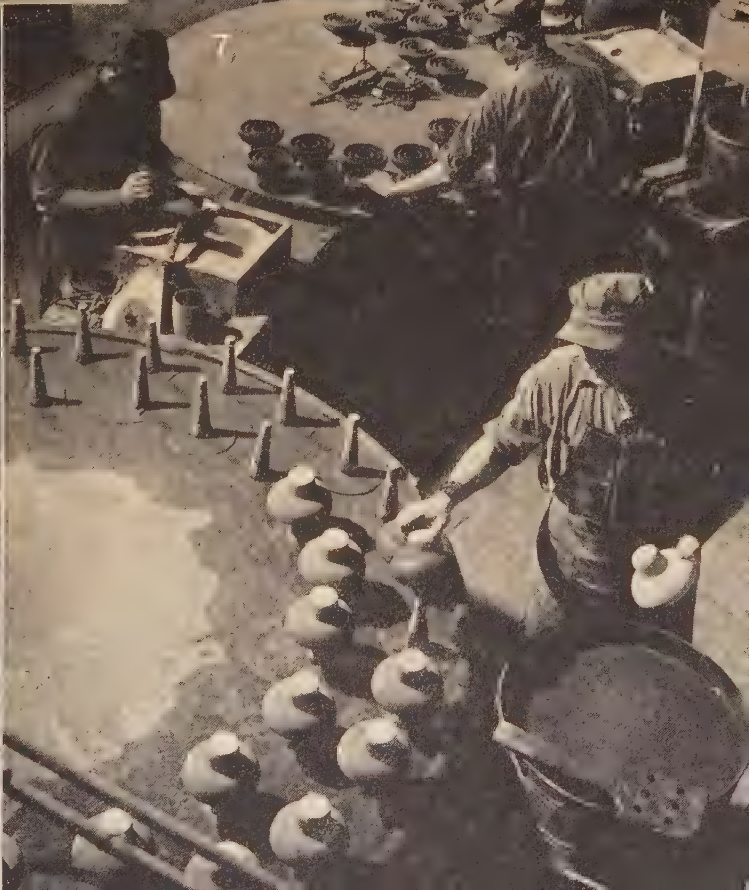
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making ingredients plus a proper color in the form of mineral salts (figure 7). Glazes of all colors become liquid in the kiln; therefore, it is necessary to keep free of glaze any surface which is to support the insulator in the kiln. Since glazes are water suspensions, it is necessary only to coat an area with beeswax or paraffin to prevent it from being covered with glaze, thus providing for a glaze-free firing surface.

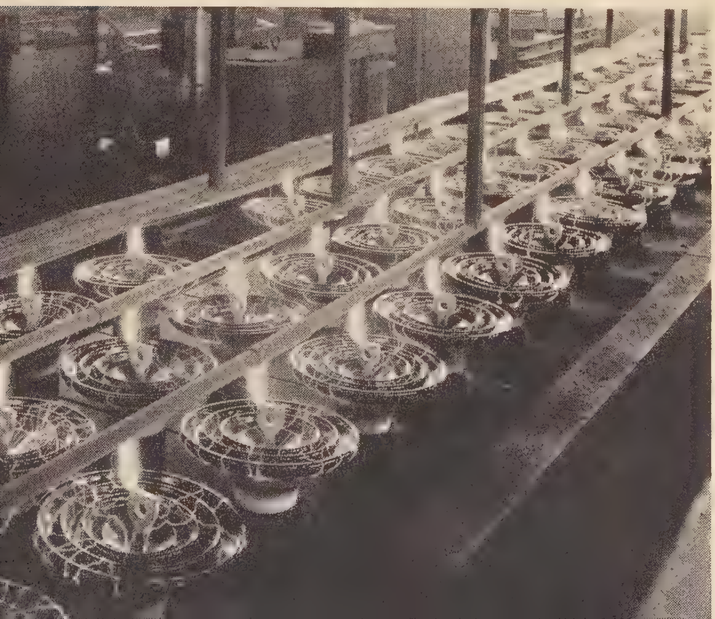
In order to assemble hardware to an insulator properly or to assemble the various parts of a multipart insulator to each other, a rough surface is produced so that portland cement may be used to form a proper joint. This rough surface, accurately positioned, is produced by firing ceramic sand on the surface of the porcelain. A band of viscous sugar-house sirup and glaze mixture is painted on the insulator and the sand is poured over this band. The sirup holds a single layer of sand grains in position until the insulator reaches a relatively high temperature in the kiln and sticks to the glaze and porcelain.

Radio-Interference Proofing

As a result of many years of study and research, line and apparatus insulation of all voltage ratings now are being produced so treated as to be free from distressing corona or radio interference due to capacitance arcs. At the Derry plant, this treatment consists of a second coat of ceramic glaze applied to the insulator over a proper and accurately located area of the insulator surface. This glaze is a normal ceramic glaze the active elements of which are several metallic salts so proportioned that when the glaze matures in the normal firing operation it becomes somewhat conducting and is actually an integral part of the insulator to which it is applied.

In conventional pin-type insulators of all voltages, the normal flow of the charging current of the insulator forms minute arcs between tie wire or conductor and insulator. This arcing flow of charging current generates varying degrees of objectionable radio interference at the insulator. The newly perfected radio-interference-proof glaze, since it is partially conducting, prevents the formation of arcs between tie wire or conductor and insulator and eliminates troublesome interference entirely at voltages well above the normal operating voltage of individual insulators. This same glaze, applied to suspension or apparatus insulators on the surface of the porcelain immediately under the lip of the metal cap, distributes the voltage stress at that point on the insulator, so that visual corona which appears on a normal insulator at from 13 to 15 kv is entirely absent at voltages of 36 kv.

Figure 9. Each wet-process porcelain piece is subjected to high-voltage tests. Here they are undergoing full AIEE 60-cycle flashover test



Firing

From the glazing table, the insulators are taken directly to the loading platform of a tunnel kiln, where they are loaded on kiln cars for firing (figure 8). These kilns are of the continuous type. Cars loaded with unfired ware enter the kiln at one end and pass through at a steady, controlled rate of speed. Temperature is raised steadily until the ware reaches the vitrification temperature at the center of the kiln. Temperature is reduced gradually after the ware passes the firing zone until it reaches the delivery end of the kiln cool enough to handle.

Inspection and Testing

After the ware is removed from the kiln cars, it passes through a series of rigid inspections. Dimensions are checked, and the pieces are examined for flaws. Typical of the thorough nature of this inspection is the flashover test given every piece of high-voltage ware.

The Derry plant is equipped with two continuous testing machines. One of these is located at the inspection floor. Each machine consists of a traveling linked belt on which is mounted a series of metal receptacles. In operation, each of these receptacles receives a piece of high-voltage ware with a metal electrode supported inside it. The ware passes first under an electrode charged at the high-frequency flashover potential of the piece to be tested. This electrode is wide enough to flash over each piece of porcelain at the speed of the moving belt (figure 9).

As the belt of the machine moves forward the pieces pass the high-frequency electrode and move under a 60-cycle electrode charged at the 60-cycle flashover potential of the piece. These electrodes are so proportioned that the piece receives the full AIEE 60-cycle flashover test. Each piece is delivered to an inspector at the delivery end of the machine, to be passed either for assembly or shipment, or to be rejected as unfit for either. The whole machine is under the control of a laboratory technician, who maintains the correct voltage.

Pieces composed of more than one part are given an identical flashover test on an identical machine after they are assembled, and again pass visual inspection before they are released for shipment.

Assembling

In the assembly of insulators to support transmission lines, minute care is given to details. A special portland cement is stored in an insulated room. Each workman withdraws from storage a small amount of cement—enough to last no more than 15 minutes. The amount is determined by weight. This cement is mixed with a carefully measured quantity of water and is machine mixed for a specified time.

Porcelains are delivered to the assembly force properly treated with resilient materials, as is the hardware. The cap, spacing washer, and a quantity of cement are assembled in proper relation and placed under a hood in a saturated atmosphere under closely controlled temperature to set. No cement that has been mixed longer than 15 minutes is used. Cleaning and final flashover and inspection completes the insulator and prepares it for shipment.

A large proportion of the apparatus bushings for transformers, capacitors, oil circuit breakers, and similar electrical apparatus, are turned. From the pug mill, the clay is delivered to steel cylinders from which it is extruded by a hydraulic ram through a nozzle over a mandrel. These cylinders of clay, each with a hole through its center, are condition-dried until they are "leather hard." Once they are properly conditioned, the clay blanks are delivered to lathes where skilled workmen, using templates and semifixed steel tools, turn the clay to shape. As with hot-pressed shapes, shrinkage from final forming to the fired condition amounts to about 16 per cent by volume, so these newly turned bushings are 16 per cent oversize in every dimension. Final drying prepares the turned bushings for glazing and sanding. This and the firing process are identical with that used on hot-press pieces.

Metallic Bonding

A most interesting process is used for soldering metal parts directly to porcelain. By this method, bushings such as those used on capacitors provide a hermetic seal, since the metal flange is soldered to the porcelain and subsequently to the capacitor tank, and the lead is brought out through a soldered cap.

A capacitor bushing, after it has been fired with standard ceramic glaze, has applied to it an accurately positioned band of an additional glaze, the important elements of which are platinum and gold. Upon firing a second time at a temperature only high enough to soften standard glaze, the metallic glaze matures and becomes a part of the standard glaze. This metallic band, after treatment with soldering flux, is tinned with commercial solder and is ready to receive its flange and lead-in cap, which are attached in a normal soldering operation. The joint will withstand pressure and vacuum and will fail under normal operating temperatures only after sufficient stress is applied to cause a rupture of glaze or porcelain—about 1,000 or 1,500 pounds per square inch.

Dry-Process Insulators

Dry-process porcelain differs from wet-process ware, so far as manufacture is concerned, only in moisture content during the forming operation. The products differ in that dry-process porcelain is more porous and will absorb moisture.

Figure 10. Irregularly shaped porcelain pieces are made in accurately machined steel dies by the dry-press method

Filter cakes are dried and ground completely. Then 12 per cent water is added in a tempering bin. The moist clay is ground into particles about the size of sawdust grains. This pulverized clay is delivered to presses equipped with accurately formed steel dies. The cavities in the male and female portion of the dies are shaped so that when they are brought together they squeeze the clay to the exact shape and proper dimensions of an arc chute, range heater plate, wireholder, or any one of thousands of special irregular pieces (figure 10). Since dry-process clay is not as plastic as that used in the wet process, this squeezing operation is feasible and permits the forming of these intricate pieces.

Cast Insulators

Large or irregular wet-process pieces are cast in a manner similar to that used for casting gray iron. A mold is made of plaster of paris. As is the usual foundry practice with flasks, these molds are made in two or more parts. Large bushing castings are made by placing the two halves of the mold vertically on a rubber gasket laid on a flat steel base plate. The two halves of the mold are held together with bolted steel bands, and the whole is held firmly between an upper and lower plate and gasket by means of stay rods. The cavity in the mold is filled by gravity with liquid clay. A static head to provide for shrinkage in the clay as it solidifies is attained by means of a steel caisson above the upper mold plate. Density of clay is governed by air pressure admitted to the header caisson.

As the porous mold withdraws moisture, the liquid clay solidifies at a constant rate. Solidification starts at the surface of the mold and progresses toward the center of the casting. Since solidification progresses at a constant rate, any desired wall thickness of casting can be obtained by leaving the mold full for a definite time. When the required time has elapsed, the liquid center of the casting is drained out, leaving a shell inside the mold. The bushing mold is returned to a horizontal position, disassembled and the casting is transferred to a cradle, where it is dried completely. The bone-dry casting is mounted on a mandrel in a lathe, is turned to exact dimension, is glazed and fired, and inspected and tested, after which it is ready for service.

Technical Progress and Social Development

By KARL T. COMPTON
FELLOW AIEE

Technology has made enormous contributions to modern society, but there still remain many attention-challenging aspects of its influence upon social development; some of these aspects are discussed here by this noted scientist-educator, who says that many future social developments can be realized only through better technical developments and better management. The type of management that is most likely to be successful in the long run will direct and inspire, but not too rigidly control.

THAT our national health, prosperity, and pleasure largely depend upon science for their maintenance and their future improvement, no informed person would deny. This opening sentence in the 1935 report of the Science Advisory Board epitomizes the judgment of that body of fifteen prominent scientists, engineers, and medical experts on the present-day influence of technical progress upon social development. It is not only scientists who hold this view. Nineteen years ago the American Federation of Labor expressed the same conviction in the following resolution:

> Whereas, the increased productivity of industry resulting from scientific research is a most potent factor in the ever increasing struggle of the workers to raise their standards of living, and the importance of this factor must steadily increase since there is a limit beyond which the average standard of living of the whole population cannot progress by the usual methods of readjustment, which limit can only be raised by research and the results of research in industry:
>
> Resolved, by the American Federation of Labor in convention assembled, that a broad program of scientific and technical research is of major importance to the national welfare . . .

Facts in support of this thesis are overpowering. Eighteen of the new industries which have grown directly out of scientific research within the past 50 years provide one-fourth of all the employment in the United States. The majority of the products now manufactured by electrical companies were unknown 15 years ago. It is estimated that 95 per cent of our chemical industry is based on fundamental discoveries made in university laboratories. A report of the Brookings Institution outlines the basic procedure necessary for economic recovery as the application of scientific methods to improve quality and decrease cost of production and to develop new products. It says that the basic necessity is to encourage science, encourage capital, and remove the artificial restrictions of regulations. Even in agriculture, perhaps the oldest of man's arts, technology has created new markets by developing transportation and storage facilities, has met the threats of food shortage for expanding populations by technical improvements in soils, seeds, and farming methods, and is seeking to develop new industrial uses for farm products in order to use the surplus which can now be produced.

We may accept the fact that technology has created enormous employment and wealth, has vastly increased opportunity, and has greatly reduced the hazards of sickness, famine, and suffering. If all this be granted, however, there still remain many aspects of the influence of technical progress upon social development which challenge attention. Four of these aspects are discussed briefly in the following paragraphs.

1. The Bogy of Technological Unemployment

In recent years much discussion has centered around technological unemployment—the loss of work due to obsolescence of an industry or use of machines to replace workmen or increase their per capita production. Are machines the genii which spring from the Aladdin's lamp of science to supply every need and desire of man, or are they Frankenstein monsters which will destroy man who created them? Startling examples of both viewpoints can be given.

If we look at industry *as a whole,* without inquiring into particular cases, we would conclude that technological unemployment is a myth, because statistics show no decrease in the fraction of our population gainfully employed during the last few generations in which machine production has become important. This is because technology has created so many new industries and has so greatly increased the market for many commodities by lowering the cost of production to make a price within reach of large masses of purchasers.

In individual instances, however, technological unemployment may be a very serious social problem, as in a town whose mill has had to shut down, or in a craft which has been superseded by a new art. Here the fact that technological unemployment does not exist as measured by over-all statistics is of small comfort to the families whose wage earners have lost their jobs.

Prepared especially for Electrical Engineering, embracing the essential substance of a paper presented at the Seventh International Management Congress, Washington, D. C., September 19–23, 1938.

Karl T. Compton is president of the Massachusetts Institute of Technology, Cambridge. He was born at Wooster, Ohio, in 1887, and received the degrees of bachelor of philosophy (1908) and master of science (1909) from Wooster College, and doctor of philosophy from Princeton University in 1912. He has received the honorary degrees of doctor of science, doctor of engineering, and doctor of laws from several institutions. He began his career in educational work as instructor in chemistry at Wooster in 1909. In 1913 he was appointed instructor in physics at Reed College, and from 1915 to 1930, he successively held the following positions at Princeton University: assistant professor of physics 1915–19; professor of physics 1919–30; research professor and chairman of the department of physics 1929–30. He has been president of Massachusetts Institute of Technology since 1930. He is a member of many technical societies, and has served as president of the American Physical Society (1927–29) and of the American Association for the Advancement of Science (1935–36). Since 1932, he has been chairman of the committee on engineering schools of the Engineers' Council for Professional Development, which committee has been engaged in a program of accrediting engineering schools (*EE, Dec. '38, p. 513–16*). He has written and lectured widely on scientific and electrical subjects, and in 1931 he was awarded the Rumford Medal of the American Academy of Arts and Sciences for his contributions to the fields of spectroscopy and thermionic emission.

I believe that two principles should guide us in these matters. Improved products and services should be made available to the public, and not forcibly estopped to protect any entrenched business or any group of workers who would be thrown out of jobs by the change, but with this proviso: The change should be made in a manner to afford generous protection to the workers affected by it. This is a definite job for management, in which efficiency should be tempered by humane considerations (an attitude which, I believe, makes for real efficiency in the long run).

Various methods are available for reducing the shock of technological changes, such as retraining workers, gradual changeover to fit the normal turnover of personnel (as followed by the telephone companies in introducing automatic switching), pensions and unemployment insurance, efficient employment agencies for labor exchange, and co-operation between industries of a community to synchronize layoffs in one company with new employment in another.

In any case, I believe that the fundamental criterion for good management in this matter, as in every other, is that the predominant motive must not be quick profits, but best ultimate service to the public.

2. Technological Progess and Culture

In discussing the influence of technical progress upon social development there is a natural tendency to emphasize only the material products of technology, forgetting that social development is more an intellectual and spiritual than a material process, and overlooking the influence of technology on the cultural aspects of society. What, therefore, is the cultural influence of technology?

The first point which strikes one, in a long range view, is that man's achievement in every age has been made possible by, and limited by, the tools at his disposal. These limitations, in fact, are recognized in the names attached to the various stages of civilization, such as the Stone Age, the Bronze Age, or the Age of Steel.

The second significant fact is that technical progress has created opportunities for cultural development, by affording the necessary time and facilities. In the ancient "golden eras" when art, literature, law, and philosophy made great advances, these were possible because the Egyptians, Greeks, or Romans possessed slaves or, in the Renaissance of Europe, serfs, who performed the menial tasks and produced the wealth which gave time and energy for intellectual and artistic pursuits to a fortunate few. Granting the intellectual greatness of Aristotle, his achievements were certainly enhanced by his freedom from ordinary work and by the services of 10,000 research assistants, put at his disposal by King Alexander to bring him information of all sorts from all parts of the world.

In our day and generation, machines and mechanical power have taken the place of slaves in producing that large per-capita productive power which makes possible time and money for education, recreation, pensions, short hours of labor, literature and news from all parts of the world, and travel. In the United States the mechanical power used is equivalent to an average of the full time work of 50 slaves for each person.

Thus technical progress has afforded opportunities for cultural improvement. To some extent these opportunities have been utilized advantageously. We wish they were utilized better, and this, again, is a challenge to management, as well as to education and religion.

3. The New Demands on Technology

A survey of present-day social problems discloses some very definite directions in which technology can assist toward their solution. Some millions of people want work—respectable, creative, remunerative, permanent employment, and not temporary makeshift jobs or doles, or the dangerous device of producing war materials beyond reasonable requirements for defense.

All, including I believe the administrators of the great relief agencies, and with the only possible exception of a few selfish politicians, would like to see it possible for the government to withdraw from the business of unemployment relief through the creation of new employment in the regular channels of industry, agriculture, and commerce. The ideal goal is reduction of federal relief, as rapidly as regular employment can take up the slack, down to a minimum which will take care of unavoidable cases of technological unemployment in the transition period between jobs and will use this labor in the improvement of the public services and facilities for which the government is responsible.

Floods, droughts, dust storms, and encroaching soil erosion have focused attention on needs for safety and conservation on a very large scale. Acts of Congress and studies of the National Resources Committee attest the concern over problems of this type.

Without giving more examples, perhaps we can summarize by saying that the unemployed want work; industry wants profits; agriculture wants new uses for its products; national resources ought to be more wisely used; natural hazards should be curtailed; labor wants shorter hours and higher pay; all the people want more wealth, lower income taxes, better health and comfort, and additional facilities and commodities.

Every one of these desirable social developments can be realized only through the action of two forces: the force of better technical developments, and the force of better management. Better technical developments call for scientific and engineering research, training of research workers, adequate funds and facilities, and time. Better management, whether in business or in government, provides adequate attention to scientific research, and requires better understanding of problems, wiser formulation of policies, and greater efficiency in their execution. How to achieve such things is one of the greatest of all the problems facing management.

4. Principles of Management

The first of the general principles of management which seem to me to be fundamental is that management is an essential attribute of decent group life. Without it there is chaos, discord, and ineffectiveness. Without it there is no security; and complete freedom from controls does not give liberty but rather the worst of all subjugations, anarchy without protection; but with management comes orderly procedure and directed co-operative effort so that the group becomes greater than the sum of the individuals which compose it. Undoubtedly the increasing complexities of modern life, due largely to technological progress, require a continually increasing degree and quality of group management.

The second principle is, at first glance, the antithesis of the first. It is that wise management involves the minimum of control and supervision consistent with reasonably smooth, co-ordinated and properly oriented operation. It is an evolutionary principle that, as individuals or groups grow in their ability to accept responsibility, the controls imposed on them are relaxed in order that they may accept and discharge responsibility. In this manner they develop their own powers and increase the contributions which they can make to their social group. This is a basic principle in training young animals and children, in training young executives, and in developing divisions of an organization.

The greatest of all management problems today is to determine the most advantageous balance between these two principles. How much management should be exercised and to what extent should it be centralized? The question arises in business and in government.

In industrial organization, in America at least, the pendulum is swinging definitely in the direction of less centralization of management, as well as of capital and of operating plant. The reason is that experience has shown too great centralization of control to be inefficient and also hazardous. The great desire of business now is to develop personnel that can wisely discharge responsibility and take initiative, rather than to depend upon an army of obedient hard-working, but unimaginative employees taking orders from the boss.

Large groups always evolve more slowly than small groups, so it is not strange that governments in many parts of the world today are rapidly moving in the direction of increasing the scope of management and its greater centralization, sometimes even into the hands of one individual. This was the trend of our industrial organizations two generations ago. A fair evaluation of this tendency in governments discloses that in many cases it has come about from natural causes, such as insoluble complications resulting from the Great War, or the previous relaxing of controls before a perplexed people had developed the power to accept the concomitant responsibilities, or for other reasons. As was the case in overdeveloped industries, the dangers in this movement in governments lie in such factors as present or future mismanagement on a large scale, disregard of the rights of other groups in the confidence and ambition of their present strength, failure to develop enough independent leadership within the group, inefficiency, and inability to secure any true evaluation of results or policies because of suppression of criticism.

The dangers confronting the less centralized democratic governments, on the other hand, are likely to be indecision in crises, inconsistency of policies, inefficiency in operations, and continual necessity of compromise between groups. We of democracies, however, believe that in the long run there is strength even in these apparent weaknesses, because they guard against rash actions, they develop the average intelligence and responsibility of the whole population and the whole setting encourages individual development and free enterprise. We find justification for our belief in the record of economic prosperity, high standard of living, and fundamental happiness of the people in those countries where democracy has been a spontaneous development from within, not imposed from without.

Some very important questions of management on a large scale are facing most of the people of the world today. Our brethren in some countries are putting their faith in the highly centralized management of dictatorships and authoritarian states. Our brethren in other countries, and we in America, have put our faith in a form of government definitely designed to serve and not to manage the citizens and to give maximum opportunity for free initiative and free expression. This situation offers a great opportunity to watch the results of the two sharply contrasting theories of management as an experiment on a colossal scale. God grant that our observation of this experiment be not interrupted by any action that will do irreparable damage to all people in both groups!

My final suggestion of a principle of management is the outgrowth of my contacts as a scientist. Experience has amply demonstrated a fact that, at first sight, seems surprising. It is that the most significant technological advances have not come out of direct efforts to make them, however well organized, but as unexpected by-products of scientific work undertaken for quite other objectives—usually for the satisfaction of scientific curiosity. Organized, directed effort is very effective in perfecting the details of a product or its production, but not in its initial discovery. This contrast is greater the more epoch-making is the new discovery.

The logical reason for this is not hard to understand. Really epoch-making discoveries are relatively unpredictable in advance. The practical solution to a difficult problem may come from any one of a multitude of directions. Really new ideas do not come to order, and are not pulled out of a hat. Who can tell in whose brain they will germinate? If an industrial research laboratory had been established a century ago to improve lamps, it would have investigated inflammable oils and gases, wicks, chimneys, and refractories. Not conceivably would it have paid attention to the leakage of electric charges through the air or to the behavior of magnets, wires, acids, and frogs' legs. Yet from these actually came the modern lighting devices.

I believe that the same logical and psychological principles operate in the field of management generally. A highly centralized and organized form of management may be very effective in performing the specific functions assigned to it in the manner stipulated by headquarters, but it is not a favorable type of organization in which to take advantage of the potential genius inherent in the group which, if given opportunity, may produce better leadership and develop more advantageous objectives and more effective operations.

So I believe that experience, logic, and human psychology all support the view that that type of management is most likely to be successful in the long run which directs and inspires but does not too rigidly control, which offers large opportunity for initiative and for criticism, and which has faith in the mass judgment of an intelligent group and in the genius which may appear in unexpected quarters. Qualities like these are basic to the type of management which has found favor and success in this country, in the home, in business, and in the organization of our government itself.

Test Barrel Devised for Surge Tests on Oils

INSULATION co-ordination on oil-circuit-breaker designs makes desirable a knowledge of surge voltages required to break down insulating oils. Because of the lack of available data on this subject a series of tests using hemispherical electrodes has been under way during the past year at the California Institute of Technology, Pasadena. One reason for the absence of data of this type, according to R. W. Sorensen (A'07, F'19) professor of electrical engineering at that institution, has been the difficulty in providing a convenient lead-in bushing for making the necessary tests. This difficulty was overcome by making a test barrel in which the electrodes were mounted, with a lead-in bushing of insulating material having about the same dielectric constant as insulating oil. Professor Sorensen has made available the following brief description of the test barrel.

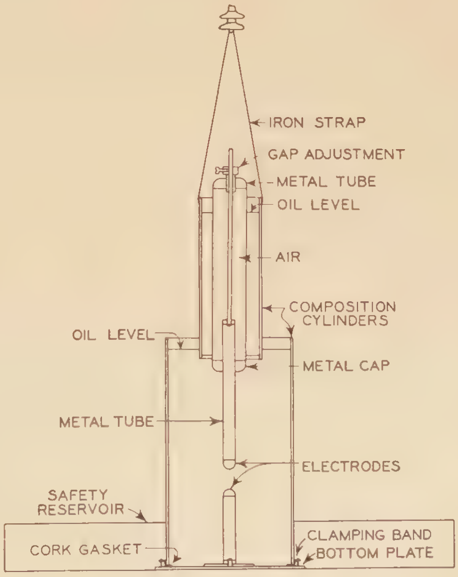
In making this device two composition cylinders made of paper and varnish were used. The larger cylinder, 40 inches in diameter and 72 inches long, forms the test chamber; the smaller one, 23 $^3/_4$ inches in diameter and 48 inches long, serves as a lead-in bushing. These cylinders were open at both ends when obtained. An oil-tight bottom for the test barrel was obtained by placing the insulating cylinder upon a steel plate on the surface of which a circular gasket seat had been machined. A cork gasket which could be clamped tightly between the end of the cylinder and the gasket seat was used. A steel clamping band, as shown in the accompanying diagram, drawn tightly around the larger cylinder by a bolt and drawn down hard upon the cork gasket by bolts through studs welded to the band and engaging threaded holes in the steel bottom, provided means for keeping this cork-gasket joint tight. Any oil leakage that might occur, due to accident or other cause, was amply provided for by placing the test barrel in a shallow oil-tight steel receptacle, large enough to hold all the oil used. With this arrangement, requiring only eight barrels of oil, the test electrodes are freer from field distortion due to adjacent materials than would be possible with the use of containers of metal or other conducting or even semi-conducting material, unless such containers were made very large. In other words, the use of oil in a barrel of insulating material having about the same dielectric constant as oil makes possible, with a small amount of oil, electric gaps immersed in what, in effect, is a column of oil insulation surrounded by the atmosphere of the test room.

Calculations before construction, and tests after construction, show that for all practical purposes this device provides a means of having test gaps in oil completely free from field distortion due to surrounding objects.

The cylinder serving as the lead-in bushing is closed at the lower end with a fiber and metal bottom designed to hold oil between it and a steel tubing concentric with the insulating cylinder and through which the upper and adjustable electrode extends into the test barrel. This metal part of the bottom is constructed in such a way as to provide for a well distributed electric field around the lower end of the bushing. The lower electrode supported by, and attached to, the bottom of the barrel was not made adjustable, but was constructed so as to be easily changed or removed for cleaning and polishing. During tests the part of the lead-in bushing between the outer and inner cylinders is kept filled with oil and flashover from lead-in conductor to the barrel is avoided by having its lower end project into the test barrel a few inches below the surface of the oil in the barrel. This arrangement proved entirely satisfactory as a means of limiting all arc-overs to the test gap.

All test electrodes used were round rods terminating as hemispheres having the same diameter as the rods. This type of electrode was chosen in preference to spheres mounted on rods or shanks, in order to avoid under-surge conditions and uncertainties regarding the influence of shank diameter upon the field uniformity around the gap, and, hence, upon the results obtained. Electrodes ranging from $^1/_4$ inch to 6 inches in diameter were prepared.

Initial results of tests made with the aid of this device are expected to be presented in a future AIEE paper.



Cross section of test barrel and lead-in bushing

Professional Phase of Engineering Education

By PARKER H. DAGGETT
ASSOCIATE AIEE

The distinguishing feature of a professional course is, or should be, that it is built on the basic engineering sciences which must precede it, and the emphasis in the course should be on a most thorough analysis of these principles as applied to fundamental practical problems, in the opinion of this educator.

ANY discussion of the professional aspects of engineering education must necessarily revert to the investigation of engineering education conducted by the Society for the Promotion of Engineering Education under its board of investigation and co-ordination. The final report[1] of the director of investigations summarized a discussion of this subject in the following words: "It is the view that the normal type of undergraduate course in engineering is of a broadly functional character of equal value in itself and as a foundation for much more explicit professional training; that this type needs to be guarded from encroachment of a vocational or *ad hoc* type of training, either for particular technical callings or for particular industries; that while it is neither possible nor desirable to restrict engineering education to a professional discipline, it would be equally undesirable to lose its present professional orientation; and that the highest type of professional education may ensue as graduate work in those engineering schools which maintain the fullest professional standards."

At the time of the investigation there was a fairly strong demand for a more strictly professional objective. Not a few argued that four years of formal training was not sufficient time in which to reach this objective, and that our curricula, therefore, should be lengthened to five or even six years. From a strictly professional standpoint this thesis is not difficult to defend.

On the other hand, what has been called "the functional character of engineering education at the undergraduate level" has been pretty generally accepted as the norm. Thus we are obliged to mold our curricula with a twofold aim in view. We must provide a training that will be useful alike to those who are destined to become professional engineers, in the narrow and legal sense of the word, and those who can best serve society by undergoing such training even though they never become professional engineers.

A large majority of the students that successfully complete the rigorous training of our schools inevitably must pass on into a lifework in which the specific technical knowledge they have acquired may be only of incidental value. For that fact, we need offer no apologies if we place the greatest good to society above the narrower aim of service to the profession. The important consideration for this group is not that they have acquired a considerable body of knowledge for which they have no use, but that they have been trained to solve problems in the same manner as the professional engineer; not that they have started out to become professional engineers and ended in some radically different lifework, but that they have been trained to think, to analyze, to weigh one scheme against another, and to develop their creative imagination by practice in design. Society has need for men of this type, and if the engineering schools are capable of turning them out, then society has a right to expect the schools to supply them.

Can the engineering schools do this job and at the same time care for the legitimate needs of the engineering profession? The answer is yes. We are doing it, and have been doing it for years.

What are the legitimate needs of the engineering profession? What is a professional engineer? According to the "Model Law for the Registration of Professional Engineers" the term means:

> A person who is qualified by reason of his knowledge of mathematics, the physical sciences, and the principles of engineering, acquired by professional education and experience, to engage in the practice of professional engineering.

Professional engineering is defined to include:

> Any professional service, such as consultation, investigation, evaluation, planning, design, or responsible supervision of construction, or operation, in connection with any public or private utilities, structures, buildings, machines, equipment, processes, works, or projects, wherein the public welfare, or the safeguarding of life, health, or property is concerned or involved, when such professional service requires the application of engineering principles and data.

I have given these quotations from the Model Law because these definitions, or definitions with closely similar wording, appear in the engineering registration laws of three-quarters of all the states in the union. In these states they are the only legal definitions. Under these laws it is the duty of all duly constituted officers of the state, or of its political subdivisions, to prosecute a person

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Full text of a paper presented at the 46th annual meeting of the Society for the Promotion of Engineering Education held June 27–30, 1938, at the Texas Agricultural and Mechanical College, College Station. Essential substance of another paper presented at this meeting, presenting an industrial viewpoint of this topic, by O. W. Eshbach (A'17, F'37) appears in the succeeding pages.

PARKER H. DAGGETT is dean of the college of engineering, Rutgers University, New Brunswick, N. J. He received the degree of bachelor of science from Harvard University in 1910, and except for a brief period has been engaged in engineering educational work continuously. He was associated with the University of North Carolina from 1910 until 1929, during which period he was successively associate professor of electrical engineering, and professor of electrical engineering; he served as acting dean of the school of applied science in 1915–16. He has been at Rutgers since 1929. Professor Daggett has been active in the North Carolina State Board of Engineering Registration and the National Council of State Boards of Engineering Examiners of which he was president in 1925–26. He also has been active in the work of the Engineers Council for Professional Development and of the Society for the Promotion of Engineering Education.

[1] Report of the Investigation of Engineering Education, Society for the Promotion of Engineering Education, volume II, page 1089.

who, without being duly licensed by the state registration board, practices, offers to practice, or who dares so much as to "use in connection with his name or otherwise assume, use, or advertise any title or description tending to convey the impression that he is a professional engineer."

In discussing the professional phase of engineering education this fact must be kept in mind: *The only gateway for admission to the engineering profession in the states that have comprehensive registration laws is by proper certification by the state boards.* This fact is not as generally recognized as it should be by the general public, or even by engineers themselves. It has been recognized by groups of engineers in some 20 states, of which 18 have licensing laws under which some 34,000 professional engineers have been licensed. In each of these 20 states a state society of professional engineers has been organized under a charter granted by the National Society of Professional Engineers.

The following quotations illustrate the type of thinking about engineering and engineering education that is going on in the minds of those to whom the legalistic aspect of the question is the all important consideration. The first, from the handbook issued by the largest of these state societies, is significant: "The only agency that can admit a man into the engineering profession is the legally authorized state board. Membership in an engineering society does not make a man an engineer. He should be an engineer before he is admitted to membership. The National Society of Professional Engineers is the only organization in which all the members are engineers."

At the last convention of the national society one of the speakers remarked from the floor: "I think that one of the objects of our society should be that of furthering the proper education of engineers, to take charge ultimately of engineering education in the United States to the extent that the American Medical Association has taken charge of the supervision of medical institutions in this country. It is one of the finest objectives that we could possibly have...." The president of the society replied: "I might say that these recommendations are fairly well advanced in the councils of the society... We hope that the time is not far distant when there will be established such standards for entrance into the profession as will make it possible to ascertain who has the best chance and also what the institutions of learning should teach."

The National Society of Professional Engineers is a logical and significant outgrowth of the engineering registration laws. At the present time it constitutes a small but vociferous minority of licensed engineers in less than half the states that have licensing laws. The avowed objective of the society is to make engineering a definitely closed profession. Whether this can be accomplished solely through the indisputable power of the licensing laws, time alone can tell.

If engineering is to become a closed profession, then it is only logical that engineering education should abandon its present dual objective. Engineering schools will exist solely for the purpose of supplying the necessary recruits for the profession. The curriculum will be one of five or six years; the number of schools needed to supply the demand perhaps not more than half the present number; and the cost to the individual and to society for the necessary educational foundation very materially increased.

Whether this is a desirable step or not depends on whether society will be served better in the end, not on the probable benefits to the individuals who have a proprietary interest in the profession, for one of the fundamental characteristics of a profession as distinct from a mere vocation is the social responsibility of the former. Society naturally will benefit, economically as well as socially, if the engineering profession, on which it must depend to maintain and to advance its civilization, possesses a wider and more profound understanding of the principles that underlie the profession, and a better appreciation of economic and social needs. A longer and more thorough professional education obviously should lead to such a result.

With the engineering schools thus strictly professionalized, the legitimate needs of the majority of students now in our schools still might be supplied by curricula not far different from the present. These might properly be administered either in a college of arts and sciences or in a school of applied science. The engineering designation, however, would be reserved exclusively for the strictly professional school.

For the present, at any rate, we are committed to a four-year program which must combine professional preparation with a broader and more generally utilitarian aim. The highest type of professional service demands that this program be supplemented by an additional period of formal study in a graduate school, by part-time study under the discipleship of a properly qualified professional engineer, or in more formal evening courses in our engineering schools. Many of the engineering schools in the larger centers of population have been awake to the possibility and the need of this phase of engineering education. Much more can, and should, be done.

From a purely professional point of view the undergraduate training should be guided by the following considerations:

1. There should be a proper balance between the cultural and humanistic subjects, the engineering sciences, and the professional courses.
2. There should be only a limited amount of specialization.
3. Emphasis in professional subjects should be on the application of the basic principles of the engineering sciences, rather than on pouring into the student the maximum possible amount of information, much of which will be out of date before he is ready for professional recognition.

The question of balance is one that is not susceptible to rigid definition. If we consider the basic courses in the physical sciences, and in some curricula the biological sciences as well, to be cultural courses, as indeed they would be in any liberal-arts curriculum, then a reasonable balance would be, roughly, one-third cultural, one-third engineering sciences, and one-third professional courses. In the cultural group the amount of English will depend on the quality of the preparation the students have received in high school. Formal work in general economics usually is considered today to be an essential. Some schools consider history, psychology, and the like to be essentials. In others provision is made for these through electives. In the basic engineering sciences we should expect to find engineering drawing and descriptive geometry, engineering mechanics, strength of materials, surveying, and hydraulics or a more general course in fluid mechanics.

A limited amount of specialization is desirable if for no other reason than that of motivation. An additional factor, however, is the fact that in many states the laws require registration in separate branches of engineering, and even in states that have passed laws more recently, where the license is granted as a "professional engineer" without designation of field, the state boards require the applicant to choose one branch of engineering for special examination. It is possible to work out adequate and satisfactory curricula in at least three of the major branches, civil, electrical, and mechanical engineering, in which two-thirds or more of the work will consist of a core common to all.

The greatest weakness in many institutions lies in the professional courses. This is a glaring defect particularly in many of the specialized curricula that are offered. The distinguishing feature of a professional course is, or should be, that it is built on the basic engineering sciences which must precede it, and the emphasis in the course should be on a most thorough analysis of these principles as applied to fundamental practical problems. This naturally places these courses in the senior year, although usually a start should be made in the junior year. All too often, however, we find senior courses that are hardly more than informational potpourris. Some are actually of the trade-school type. To take a fairly simple piece of equipment apart, put it together again, make a sketch of it, and then write a brief descriptive report on it, scarcely can be called professional training.

Where such a situation exists, the fundamental philosophy of the school is often at fault. In some fields, however, we can place the blame, in part at least, on a lack of the proper kind of textbooks. We need texts in which the functional idea is carried out to the fullest possible extent, rather than more books with elaborate descriptions of this or that machine, profusely illustrated, and filled with information that can be obtained more easily, more interestingly, and more effectively from manufacturer's bulletins. We have some splendid texts for the courses in engineering sciences. How many really satisfactory texts are there, for example, in the field of alternating current machinery?

Professional courses should train the student to think, to analyze, and to develop his creative imagination by practice in design. Unless they do this they are vocational rather than professional in character.

Finally, it is an essential part of the engineering educators' job to give the students some insight into the professional life that awaits them. This is not an easy matter. The present status of the engineering profession is somewhat confusing. For years engineers have struggled for more adequate professional recognition on the part of the general public. On the one hand they have been damned almost with faint praise for their greatest works, while on the other hand they have been blamed for the economic debacle that has followed the unintelligent use of these works. They have stood by while the honored name of "engineer" has been applied to almost every field of human endeavor from the vocational trade of a plumber to the field of a social worker. They have developed their organized professional life through the mediums of separate professional societies for each individual branch, rather than a single unified organization like the American Medical Association or the American Bar Association.

The professional status of most engineers today is entirely different from that of the doctor or the lawyer. In the first place, by the very nature of his work, even as a private practitioner, he inevitably must serve large corporate groups for the most part, rather than individual citizens. In the second place, the great majority of engineers today are, and always will be, employees of these corporate groups. Therefore, they must be resigned to seeing their individual efforts synthesized in the conglomerate product, while the *individual* lawyer receives credit for winning a case, the physician for saving a life.

Increased professional recognition will come only as fast as, and in so far as, it is merited by professional development. Even though the engineer is destined to be more submerged in the economic group, he still can conserve and develop his professional identity. By preparing himself for a better and more profound understanding of the underlying principles of his profession, for a better appreciation of the civilization he is building, and by developing and exercising whatever innate qualities of leadership he may possess, then, and only then, can he be assured of a larger place in "this sorry scheme of things."

Illumination Notes*

A Midget Sun. A 1,000-watt mercury-vapor lamp, no bigger than a cigarette, with an intrinsic brilliancy about one-fifth of the sun's, is now available. The lamp itself is a capillary quartz tube containing electrodes, a drop of mercury, and a little argon gas for starting. The heat and pressure are such that water-cooling is necessary, so an outer tube is provided as a water jacket about the size of a shotgun cartridge. The light is much whiter than that of the well-known low-pressure mercury-vapor lamp. If the outer tube is made of quartz instead of hard glass, the lamp is a powerful source of ultraviolet radiation. The efficiency is about three times that of an incandescent lamp of corresponding wattage. Suggested uses are in projection, photographic processes, and therapy.

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*Contributed for the AIEE committee on production and application of light by L. A. Hawkins (A'03, M'13) executive engineer, research laboratory, General Electric Company, Schenectady, N. Y.

An Industrial View of Engineering Education

By O. W. ESHBACH
FELLOW AIEE

Industry needs both the highly professional education that is prerequisite to the expectancy of further future development of new products and methods, and the more diversified preparation that is vital to operation and management. The united efforts of all engaged in engineering education are necessary if the best program is to be achieved.

THROUGH recent emphasis placed on the word "professional" and current activities of engineering bodies, the idea is frequently expressed that a narrow concept of engineering as a profession is likely to result and be accompanied by an orthodox or standard undergraduate procedure. May future history show that this is far from the truth! The forces which will probably be most dominant in gradually affecting and shaping the character of engineering education will be: first, the desire to do a good job in taking what comes and shaping it to fit the requirements of the environment; second, an idealistic concept of the social purposes served by the application of technical knowledge; and third, the consciousness that individual development of personal qualities, of which character and idealism are among the most important, is a vital part of any educational program.

To be specific, the services as developed by the Polytechnic Institute of Brooklyn in the metropolitan area of New York and those developed by the Agricultural and Mechanical College of Texas, are not interchangeable except in certain fundamentals which are universally recognized and characteristic of all technical education. Second, the day is past when any large number of graduates can expect to go from school to industrial life and immediately apply a certain technique which they have learned, regardless of the environment in which they are, the individuals with whom they have to work, and the ultimate purposes of the project in which they are engaged. Third, no profession can expect to be held high in public esteem unless the highest qualities of manhood characterize its personnel.

Engineering education has been regarded as a bread winner but what educational program has not? There is a difference, however, in the public viewpoint which does not depend so much on the presence of vocational aspects as it does upon the expectancy of attitudes and ideals that accompany and characterize the actions of different educational or social groups. The question, what is a profession or, in other words, just what are we talking about is a natural sequel. That there is a didactic problem in establishing professional consciousness is evident.

The use of words is most carefully guarded in the legal profession, yet Justice Holmes has been quoted in one of his decisions as saying: "A word is not a crystal, transparent and unchanging; it is the skin of a living thought and may vary greatly in color and content according to the circumstances and time in which it is used." The content of the words "professional engineering" imply the following of a calling or vocation in the art of applying physical truths to the establishment of social conveniences, and the profession itself is the body of individuals so engaged. To restrict its meaning so as to apply to special acts may give it legal significance or technical meaning to a special group but it does not change the popular or genetic sense.

It must be recognized, however, that legal phases of the profession are implicit in it and any acts jeopardizing life and health should be engaged in only by legally authorized persons. As affecting educational procedure there are important aspects of the legal phases. Part of the evidence of competence is based on the quality and content of formal instruction and a professional school may not neglect training vital to public protection.

In discussing other professional phases of engineering education more emphasis may well be placed on the color as distinguished from the content of the words. Taking a personal rather than a legal view of a profession it might well be defined as follows:

> Any occupation is a profession which, in affecting the general welfare, has as a necessary prerequisite to skill a common body of knowledge requiring extended concentrated education and training and employs people held high in public respect, who put service before personal gain, who are actively conscious of their social obligations, who adhere to a written or unwritten code of ethics, who consider their work as involving life-long study, and who are willing to make sacrifice for the advancement of their field of activity and the individuals in it.

The thoughts here expressed are worthy of further analysis as they apply to engineering education.

Industrial Aspects of Professional Engineering

It is apparent that engineering education in the present era is the most suitable preparation for industrial life

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Essentially full text of a paper presented at the 46th annual meeting of the Society for the Promotion of Engineering Education held June 27–30, 1938, at the Texas Agricultural and Mechanical College, College Station. Another paper presented at this meeting, discussing the professional phase of engineering education, by Parker H. Daggett (A'08) appears on the preceding pages.

O. W. ESHBACH is special assistant in the personnel department of the American Telephone and Telegraph Company, New York, N. Y. He is a native of Pennsburg, Pa. (1893) and received the degrees of electrical engineer (1915) and master of science (1920) from Lehigh University. Except for a period of service in the United States Army during the World War, he spent the early years of his career in teaching at Lehigh, being appointed instructor in electrical engineering in 1916, and assistant professor in 1920. In 1923, he became assistant engineer with the Bell Telephone Company of Pennsylvania, his work being associated with the employment and training of engineering graduates. He received his present appointment in 1925, his duties involving educational and employment work. Mr. Eshbach has been a member of the AIEE committee on education since 1931, and was chairman 1935–37. He also has been a member of the publication committee since 1935, and has served on several other Institute committees.

and as such should be based upon broad concepts of the social purposes which it serves. The fact that different concepts exist would seem to justify differences in objectives and curricula. In an article "Industry Demands and Engineering Education" (*EE, April '34, p. 518–22*), L. W. W. Morrow suggests the establishment of two types of curricula as a part answer.

> 1. A course for the mass of students that is based upon a broad education developed largely from science, engineering, and economics and taught by teachers using engineering methods and having both business and engineering knowledge, so as to train men to staff and operate mechanized industry.
>
> 2. A course with very high standards in science and engineering to be taught by scientific and engineering specialists to be given a selected number of students so as to train men to supply the specialized technical needs of industry—the future professional engineers.

In considering a program such as this, it might also be advisable to raise the question as to whether the two courses should be given *concurrently* or *sequentially*.

Industry has a stake in engineering education. While it would be wrong to emphasize unduly the service function of the engineering schools in filling industrial needs for technical and leadership talent, nevertheless the hopes and ambitions of most of the boys who choose engineering careers are related to the objectives sought by the schools and the profession. Industry needs both types. Highly professional education is prerequisite to the expectancy of further future development of new products and methods. More diversified preparation is vital to the operation and management of industry in which necessary occupations are difficult or impossible to correlate with the professional divisions of engineering education as they now exist. Nevertheless, these activities require a knowledge of engineering facts and understanding of the fundamental laws underlying applied science.

In the report, "A Study of Engineering Education" published by the Carnegie Corporation 20 years ago, C. R. Mann says:

> The ultimate aim of engineering education has always been and still is more intelligent industrial production. Technical schools were founded when industrial evolution had progressed so far as to create a pressing demand for men who knew how to utilize the new and rapidly expanding knowledge of natural science to increase and improve production. Science was then little taught in high schools and colleges, so that both the public and the manufacturers were ignorant of it. Under these conditions the obvious need was for scientific enlightenment; and this the engineering schools were organized to supply.

The statements that the immediate aim was to supply the intellectual element in production, and that this meant knowledge of the fundamental principles of science, were true when they were first made in 1861. Also from the same report:

> The net result is that the curricula and methods of instruction that were devised to supply the intellectual element in production by imparting knowledge of natural science must be reorganized to meet the new industrial demand for engineering administrators and the larger professional demand for men of strong personality. The general plan of the proposed reorganization is based upon an analysis of engineering practice into its three essential factors; namely, knowledge of engineering science, skill in technique of application, and judgment in the appraisement of values and costs. In every engineering project the overlapping claims of these three essential factors must be harmonized with respect to the two fundamental elements of production, namely, materials and men. Surely every engineer should have some conception of the present conditions and problems in at least the general aspects of all these essential factors and elements. If this be granted, it is easy for any school to discover where its curriculum is overloaded and where it is deficient.

Professional demands are for a continuing education longer than institutional, broader than technological, embracing the humanities and obligations of public service. At the same time educators and society are concerned with the best way of meeting the needs of young men of varying talents both in aptitude and native ability. This emphasizes the fact that the problem is just as much human as it is technological.

Specialization Versus Generalization

To arrive at a reasonable conclusion as to the degree of generalization or specialization desirable in engineering education necessitates stating as clearly as possible those factors in which there is likely to be fairly general agreement. Among them the following are pertinent: first, the desirability of an individual's early determination of a life career; second, the necessity of providing flexibility in our educational system for the many who, for one reason or another, are unable to make such a decision; third, the desirability of sound, fundamental education in literature, arts, and science, which impart emotional stability, social understanding, character, and adaptability to later professional or industrial specialization; fourth, the necessity for stimulation which comes from directness of purpose and a close contact with practical application.

First of all it must be recognized that whether desirable or not, students must be educated for a more or less indefinite future. Second, if the idea is accepted that education begins and ends with life, the seriousness of a dogmatic answer is at once avoided, for it would seem to make little difference whether the individual aimed at a specific objective first, and at leisure pursued general educational improvement, or reversed the process. It is appropriate, therefore, to say something about the virtues of specialization not only in support of what exists but because specialization represents a natural, easy, and effective process of development.

The development of engineering education reflects the virtue of the idea of "usefulness." Unfortunately, the zeal with which the basic sciences underlying construction, mechanics, mining, chemistry, and electricity were developed by specialists led to prescribed courses looking toward specialized education in these several fields. The practical result has been the injection of a great mass of science into heterogeneous industries. With time comes the realization that the traditional engineering courses do not find their counterpart in industry clearly defined. This has led to the feeling that a reorganization of engineering education along functional lines might be more appropriate. Careful scrutiny of this question discloses just as serious educational objections as the present organization offers. The most practical suggestion yet offered has been that of a bilateral subdivision or functional specialization of our traditional courses toward their termination. The most serious practical obstacle to this change lies both in the lack of suitable basic material upon which courses could be soundly based, and also in the limitations of time. The statistical discovery that the specialized curricula in engineering have produced a surprising number of industrial managers whose occupational pursuits in an executive capacity are frequently far removed from the science they studied has been used in rebuttal of the suggestion that courses be liberalized so as to specialize in the art of producing managers. A few simple observations in industry will show that intensive application to specialized jobs or to specialized education has been the ladder upon which embryo managers have climbed. In fact, this seems to be so overwhelmingly true as to lend substantial proof to the theory that objectiveness or specialization in education or in industry are highly desirable. Gradually assimilated administrative experience is much more important than theories obtained in organized study. If this is so, it adds still more importance to emphasis on educational guidance and the sound building of curricula which, exhaustively, rather than superficially, drill the student in the fundamental sciences underlying the several professional choices. It would also seem a fair conclusion that the many other subjects seeking admission through too much generalization could well be learned in the school of life. What is really important is a thorough knowledge of at least some useful pursuit, and a stimulation of desire to learn something about the social, economic, and aesthetic aspects of problems related to those of immediate professional concern.

Dangers of Specialization

While the virtues of specialization are pertinent to this discussion it is just as important to recognize the dangers. Quoting again from Doctor Mann's report of 20 years ago:

> The statement that individuality counts for as much as learning for the engineer, just as it does for the lawyer or the physician, seems like a veritable platitude. Yet because the engineering schools have always made it their chief aim to impart the technical information needed in industrial production, and because both scientific knowledge and industrial practice have grown so rapidly, the attention of technical schools has been focussed chiefly on keeping up to date in science and practice. The university emphasis on research in natural science has also tended to magnify the importance of technique and to minimize the importance of personality until curricula have become so congested with specialized courses that students generally regard literature and sociology as unnecessary chores, to be endured rather than enjoyed. Therefore it seemed necessary to consider the question whether this emphasis on technique is producing a new and higher type of engineer, or whether the engineering profession still stakes its faith on the fundamental thesis that personal character is, after all, the real foundation for achievement.

In every occupational level there are too frequently those who have become self-satisfied because of a conviction of having attained expertness. They lack objectiveness in personal development, and assuming social responsibility, their mental growth ceases; new ideas fail to take root and further change of outlook is no longer a natural expectation. It is important, nevertheless, to emphasize that in the early years of a student's industrial career his chances of gaining recognition depend on his ability to surround the technical details of his specialized job. The danger is that in the intensity of his concentration and in the effort to attain a proficiency in his immediate work, he may not gain insight into the full intellectual and social bearings of his vocation. He may fail to develop interests in fields outside his immediate work. He may fail to develop an awareness of the evolving situation about him and may not sense the economic and social tendencies affecting his own industry and job. He may capitulate to the demands of his immediate work and develop a warped or narrow viewpoint rather than a well-balanced education in book and life and an insight into the important elements of human experience.

When such a man, because of good native ability, is given responsibility which requires co-ordination of the efforts of others he often discovers the need for those cultural and educational values tangential to his environment which he has had to forego in his early career. He finds that he has neglected those broader fields of knowledge which would have opened the way to generalizations and which would have provided resources for the imagination in arriving at proper conclusions. He sometimes finds himself striving in a world in which all sorts of complex economic and business phenomena are present, the causes and consequences of which he distinguishes vaguely or not at all. He lacks ability to absorb the lessons of experience in his environment, because he is not sensitized to the critical appreciation of their values.

If he senses his inadequacy and realizes that the evolution of the industrial world has proceeded faster than his own development, he will seek to equip himself with the tools and the technique with which to challenge vague impressions, emotions, and tradition, and reach sounder, more broadly considered conclusions on the business problems he faces.

If he does not realize his own lack of preparedness, or if he lacks the intellectual curiosity and stamina to bring himself up to date, he may soon be listed as human material which is obsolete, depreciated, and inadequate.

Training Emphasis

If the genetic interpretation of the meaning of the word "professional" is permitted the factors which have been discussed are important to the perspective of undergraduate education and certainly the professional phases are broader than technological.

In every educational program there are the elements of training. The term "education" is usually descriptive of a process of acquiring skills, attitudes, and knowledge to aid in meeting situations which cannot be determined specifically in advance. Education has objectives which are not as confined or as definite as those of training, which usually is restricted to organized learning-process procedure designed to meet a clearly defined problem or situation which is known in advance.

Among the important training objectives in professional engineering education I would emphasize the following:

1. Through the medium of English, report writing, and seminars, developed facility in simple writing, direct speech, and concise thinking.

2. Through language, literature, and reading expand the vocabulary of students and their appreciation of word meaning.

3. Through drill in mathematical examples develop the use of mathematics both as a tool in the solution of problems and as a language in the expression of physical concepts.

4. Through drawing and geometry develop reasonable skill in picturing physical apparatus and engineering specifications in the mind of the student and for transmission to others.

5. Through shop and laboratory develop facility in handling machinery and as many types of measurement apparatus as are generally used in engineering practice.

6. Through the study of science develop facility in observing physical laws and forming clear physical concepts of them.

Educational Emphasis

Education implies at least the acquisition of knowledge and skill in applying it to new situations. The processes are continuous through life. The things to be known professionally are legion. An attempt to introduce as much knowledge as possible of any special field results in overcrowding and immediately introduces the problem of selection. What things are important? The things which open up or are basic to practices of broad application in the industrial world today or that can be foreseen in future work would seem to be the points of emphasis. In the field of technology an experienced teaching staff can usually sense the relative importance of subjects and drop or add courses from year to year.

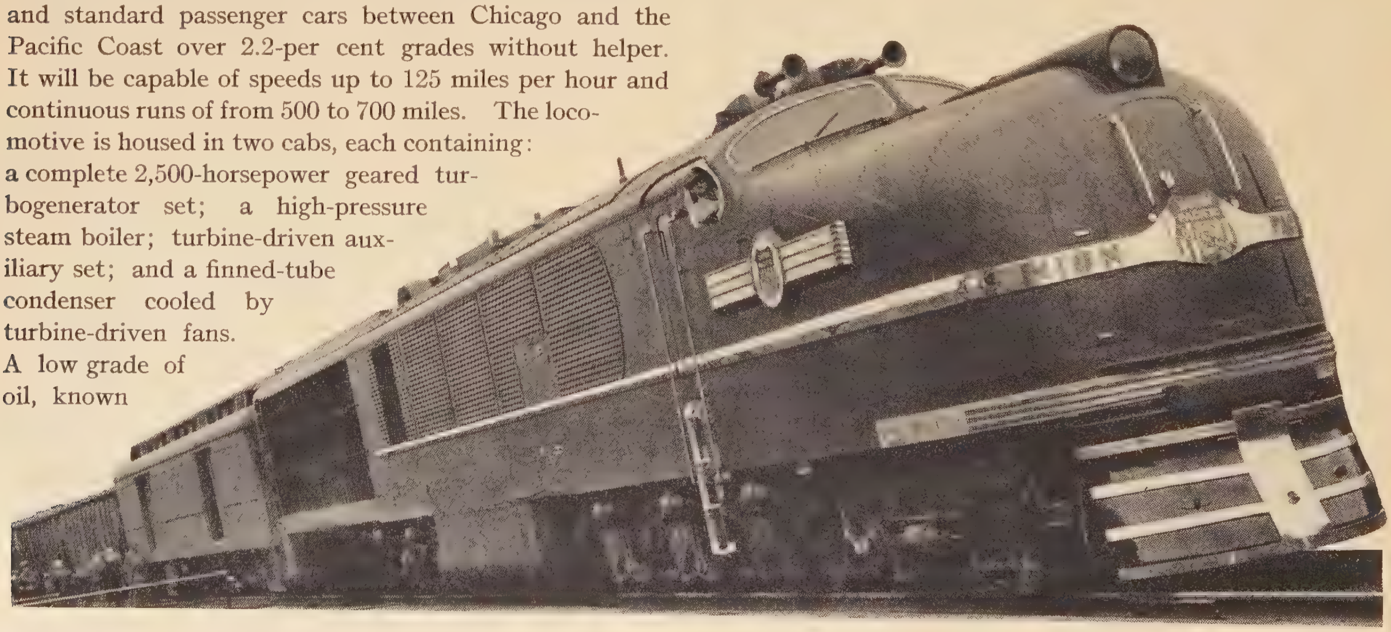
In the desire to lay as broad a technical foundation as possible, which includes the sciences of physics, chemistry, mechanics, and professional technology basic to each of the several divisions of engineering, the values inherent in developing attitudes, appreciation, and understanding of the human factors in life experiences must not be overlooked or crowded out of the picture, because it is in this phase of education that professionalism becomes distinguishable from trade occupation.

The color as distinguished from the content of professional practice has its root in culture, intellectual attributes, and traits of character that determine public opinion and insure respect.

The united efforts of all engaged in the educational profession are necessary if we are to solve the problems of finding the best organization, of constructing the best curriculum, of selecting and developing the best students, and of stimulating a program of life study under conditions that command respect and public recognition.

Steam-Electric Locomotive Completed for Union Pacific Railroad

CONSTITUTING an electric locomotive with its own complete turbogenerating unit on board, the 5,000-horsepower steam-electric locomotive that has been under construction for nearly two years recently was completed at the Erie, Pa., works of the General Electric Company. Shown below attached to a test train, it will be subjected to a series of exhaustive operating tests before being placed in regular service. The locomotive is intended to haul passenger trains consisting of as many as 12 Pullman and standard passenger cars between Chicago and the Pacific Coast over 2.2-per cent grades without helper. It will be capable of speeds up to 125 miles per hour and continuous runs of from 500 to 700 miles. The locomotive is housed in two cabs, each containing: a complete 2,500-horsepower geared turbogenerator set; a high-pressure steam boiler; turbine-driven auxiliary set; and a finned-tube condenser cooled by turbine-driven fans. A low grade of oil, known as "bunker" oil, is used for fuel. Steam pressure and temperature are, respectively, 1,500 pounds per square inch and 920 degrees Fahrenheit. Complete automatic control is provided for boiler, auxiliaries, and power units. Twelve axle-hung geared motors drive the locomotive, six being supplied from each main generating unit. Speed is controlled by varying the field current of the main generators. Electric braking is employed.



Progress in Insulation Research—1938

By J. B. WHITEHEAD
FELLOW AIEE

Continuing a series based on the annual report of the chairman of the Conference on Electrical Insulation of National Research Council, this article presents a summary of the principal research work on gaseous, liquid, and solid dielectrics during the past year. A comprehensive list of references is included.

THE PAST year, in spite of the depressed situation in business, has seen little diminution in the volume of literature in the field of dielectric research. There have been perhaps fewer noteworthy developments in applications of new knowledge to the problems of insulation. However, basic research in the fields of chemistry and physics has continued its attack upon the problems of atomic structure and molecular assemblage. It is not often that these studies yield information immediately applicable to the problem of insulation. Nevertheless, there is found increasing discussion of the conditions controlling the presence and quantities of free electrons and free ions, which eventually will doubtless lead to better pictures of dielectric loss and dielectric strength in dielectrics when used as insulators. There have also appeared some interesting papers on dielectric absorption and dielectric loss as they appear in insulators.

From the practical standpoint, the outstanding characteristic of the year's work is the large number of new insulating materials that have appeared, principally of the synthetic and composite type. These are mostly in the field of the plastics with control of the ultimate physical properties by means of varied programs of assemblage and treatment. A few new materials of ceramic type have also appeared, mostly for various high-frequency service. So far classification and co-ordination of these materials is impossible, owing to incomplete available description and to the very large numbers of different materials. A recent article states that in the resin class more than 800 different commercial varieties of resinous insulating materials with an almost equal number of trade names, have appeared within the last few years.

As is usual in these reviews, description is confined to those researches which have come to the author's routine attention, and particularly those which seem to have a bearing on the application of dielectric properties to the problems of electrical insulation.

Gases

In gases the most important insulating characteristic is that of breakdown strength. Studies of this property indicate wide variation with the geometry of the opposite electrodes. Persistent efforts, however, particularly those using the cathode-ray oscillograph, and other methods for following short-time phenomena, have resulted in a well-developed theory to which there is widespread agreement. The basis of this theory is the Townsend picture of ionization by collision, for which, however, important modifications have been necessary. These have to do principally with the part played by the positive ion in final spark-over. Such open questions and differences of opinion as remain are largely concerned with the sequence of phenomena in breakdown in nonuniform fields, under impulse voltages, and in other special conditions. In these directions Rogowski and Wallraff[1] have examined the question whether the breakdowns over large gaps are due to local high stresses caused by space charges, or to ionic bombardment of the cathode. They examine the question theoretically, drawing on foregoing results of other workers. They conclude that for large gaps and high pressures space charge breakdowns are possible; however, that in general this effect does not enter and that the beginning of breakdown even in large gaps must be attributed to the ionizing action of the positive ions. W. E. Bowls[2] reports experiments in the same field and reaches the conclusion that the secondary ionizing mechanism necessary for the increased production of electrons requisite to spark-over is not due to ionization by positive ions in the gas. He finds that the positive ions strike the cathode with energies in the range of from two to five volts, which is sufficient to cause the liberation of new electrons by positive-ion bombardment of the cathode.

There is evident a revival of interest in the theoretical study of the formation of corona in the coaxial cylindrical field. L. B. Loeb[3] contributes a short theoretical paper invoking the action of the positive ion in knocking electrons out of the cathode, offering an explanation of the variation between positive and negative starting potentials at low pressure. H. Prinz[4] presents a critical study in the same field, introducing the distortion of the field by space charges, the mobilities of the ions, and the effect of polarity. He arrives at a new expression for the

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The author wishes to acknowledge his indebtedness to several members of the Conference on Electrical Insulation of National Research Council who have drawn his attention to important published papers.

1. For all numbered references, see list at end of paper. The list contains references to all works mentioned in this report and to a number of other papers to which a more extended reference has not been possible.

corona loss in terms of the applied voltage, finds good agreement with his own results, but departures from the results of other workers. L. G. H. Huxley and G. H. Bruce[5] report an examination of corona formation and growth from the standpoint of the Townsend theory, with particular reference to the passage from stable corona to disruptive discharge. Based on experiments, they conclude that stable corona passes over into unstable disruptive discharge when the difference of potential between wire and cylinder is practically the same as for spark-over between parallel planes under corresponding conditions. A. Güntherschulze and H. Betz[6] study the corrosion of metals by corona. On silver the resulting film is silver nitrate if the relative humidity is above 95 per cent, the action being entirely chemical. With relative humidity less than 45 per cent the action is electrochemical, silver oxide and silver nitride being formed, with thickness of the film proportional to the duration of the action.

Studies of breakdown and spark lag in short and long sphere gaps are reported by R. Strigel[7,8] in two papers. A method of statistical analysis is described, which permits a study of the variation of the spread of observed results as related to test voltage, electrode metal, ionization in the gap, and aging of the electrodes. The scattering of the values of the time lag of short spark gaps is determined statistically for a rectangular voltage wave. In a uniform field, with increasing voltage the scatter time approaches a definite lower limit which is reached when, during the scatter time, on the average one electron is liberated at the cathode by photoelectric influence. The statistical scatter time is, therefore, dependent on the work function of the cathode materials and independent of that of the anode. Surface influences such as grease, oxides, sulphides, and aging due to foregoing discharges may lower the scatter time by several orders of magnitude. Similar studies for gaps up to six centimeters are examined, followed by an interesting qualitative and quantitative picture of the sequence of physical phenomena leading to breakdown, and involving space charge, abnormal potential gradients, and the velocity of the electron avalanche. He concludes that the passage of the foregoing canal or avalanche discharge into the final spark-over, in the case of point to plane, attains a velocity of several thousand kilometers per second, while the velocity of the following principal discharge is of an order ten times as high. Charlton and Cooper[9] find that the breakdown strength of some gases can be appreciably increased by admixing the vapors of carbon tetrachloride and certain other fluids. J. Slepian and R. C. Mason[10] criticize the conclusions of Cobine and Power that Paschen's law is obeyed for the re-ignition potential of an a-c arc. In substantiation they utilize a new method of plotting results whose validity is confirmed by the studies of Paschen's law by several other workers. In the case in question, however, wide variation is found.

A. Güntherschulze[11] presents an extensive and interesting description of the electrical properties of gases with numerical values throughout. Subjects covered are specific resistance; dielectric constant, including dipolar components; dielectric losses and dielectric strength, with particular reference to sparking at atmospheric pressure; corona formation, brush discharge, and the electric breakdown between plane parallel electrodes, with extension to the discussion of lightning phenomena. It presents no new results, but constitutes an important survey of contemporary theory.

Two papers on the calibration of sphere gaps are of interest, that of R. Davis and G. E. Bowdler,[12] using impulse voltages, and that of F. S. Edwards and J. F. Smee,[13] 50 cycles up to 1,000 kv.

Liquids

As is usual, the literature on studies of the properties of dielectric liquids is very voluminous. A large part of it, however, is in the field of pure chemical and physical research in which, while electrical properties are studied, it is not often possible to correlate the results with the behavior of the complex liquids used in bulk for electrical insulation. Nevertheless continual effort is being made to bridge this gap between the controlled conditions of laboratory studies and those inherent in the use of liquids in large bulk for commercial manufacture.

Dielectric Loss

Additional evidence has appeared (Balsbaugh[14]) that the losses in oils in the low-frequency range are commonly due to ionic conduction. As the frequency is raised through the radio range, dipolar losses begin to appear. A number of papers have appeared on the measurement of losses at high frequency. Practically all of them are resonance and resistance substitution methods. The variation of power factor with frequency takes on various types according to the liquid, sometimes increasing, sometimes decreasing, sometimes passing through a maximum, sometimes being practically horizontal. The curves do not present the sharp variations of power factor and dielectric constant commonly attributed to a clear polar content and are probably to be ascribed to the presence of several constituents having different values of ionic mobilities and dipolar properties (Wulff and Schwindt,[15] Borel[16]). J. Borel shows that distilled water added to a number of representative oils with thorough agitation often results in a lowering of both d-c conductivity and a-c loss. R. H. Cole[17] discusses the phenomena of dispersion and absorption in polar liquids and finds that the Onsage theory of the local field agrees quite as well with experiment as does the Debye theory of hindered polar rotation.

The interesting series of studies on spark lag in oil in uniform and nonuniform fields has been continued by R. Strigel.[18] The special contribution made by Strigel to the phenomena of breakdown in both liquids and gases is his introduction of statistical methods for analyzing a large number of observations. In the present work he studies the causes of the differences in the building-up time of spark-over, as observed in uniform and nonuniform fields. He suggests that the difference is to be attributed to extremely fine fibers in the oil which, with absorbed moisture, serve as conductors tending to line up and facilitate discharge, thus accounting also for the slow rise of the building-up time with increasing gap width. E. Conradi[19] in similar experiments, but using visual observation of magnified views of the interspace between electrodes, finds other influences than fibers, and indicates their relative importance as related to the range of voltage stress. He finds that filaments and dust particles sometimes act as conductors and sometimes as dipoles. The greatest lowering of breakdown voltage is caused by damp fibers, and the lowering effect of moisture is caused by the consequent increase of conductivity of fibers and liberation of gas. Breakdown due to ionization arising from the presence of air is conspicuous only above 175 kv per centimeter.

Breakdown in the extreme upper range of pure insulating liquids has been attributed by Nikuradse to ionization by collision, as based on the d-c current-voltage curve above saturation. Toriyama, Shinohara, and Ichimura[20] from an experimental study, conclude that breakdown is in no way related to the current-voltage curve, and that while conduction at lower voltages is ionic, the breakdown is due to the collisions of electrons rather than ions. Confirming the results of a number of other workers, they find no relation between d-c conductivity and dielectric strength. A. Imhof[21] reports a series of studies on the voltage at which surface discharges appear on various forms of insulation immersed in transformer oil.

J. B. Whitehead

STABILITY

The problem of stability is twofold as related to the particular type of service to which the liquid is to be put. In the one group are oils of the transformer type which are used for submersion, and in which the important properties are continued fluidity and dielectric strength. In the other group are the oils used as impregnants, as found principally in capacitors and high-voltage cables. The volume of work recently reported is not great for either one of these fields, but that which has appeared is of interest and indicates good progress in an extremely difficult problem.

In the field of transformer oils the action of oils on metals has been studied by Ornstein, Haringhuizen, and Was.[22] Copper is found to give the largest quantity of sludge and a relation is found between the percentage of aromatic constituents in the oil, the frequency of the applied voltage, and the amount of sludge formed. It is suggested that to prevent corrosion by insulating oils copper should be protected by a layer of another metal, tin and lead being found useful for this purpose. It is stated that acidity is not a determining factor in corrosion. Bruckman[23] proposes a test for the artificial aging of transformer oil by heating at 100 degrees centigrade for 100 hours under applied electric stress of 20 kv per centimeter. It is stated that changes in the electrical properties of the oil in this test follow closely those observed on oils in service over a period of a year. Borel[16] states that water has no unfavorable influence on the dielectric loss of transformer oils. In fact, the losses measured for both alternating and direct current are found to be often less than those of dry oils. H. Weiss and T. Salomon[24] review and discuss the foregoing papers in the report of the committee on insulating oils to the International Conference on Large High-Tension Systems.

Stability in impregnating oils has been a problem for many years. Instability is the word used to describe the slow deterioration of high-voltage impregnated-paper cables. It has generally been assumed that the causes are to be sought in the impregnating liquid. Working in this direction, J. C. Balsbaugh and associates[25] have continued a long series of careful studies on oxidation in various types of oil. So far these studies have been based principally on the chemical analysis of the products of oxidation in commercial and in synthetic insulating oils and also in other hydrocarbon liquids. The Grignard test is emphasized as most generally useful for indicating deterioration of this type. No marked correlation has as yet been found between electric properties and chemical deterioration. However, synthetic hydrocarbons have lower dielectric losses than the insulating oils; oils having a large ratio of dielectric constant to density show rapid deterioration under oxidation; a discussion of volatile deterioration products indicates that their influence on impregnated paper is not yet known. The losses from 40 to 400 cycles and at two volts per mil are due to ionic conduction. J. D. Piper and associates[26] have continued their studies of systems composed of liquid paraffin and cupric and lead soaps of a number of fatty acids. Systems containing cupric soaps of individual acids have low power factors and conductivities at all temperatures, including those near which the soaps separate from the solutions. Systems containing mixed soaps prepared from cupric abietate and certain acids or other soaps have high power factors, conductivities, and dielectric constants at certain temperatures. The dielectric properties are believed to be related to the state of dispersion of the soaps in the oil. K. S. Wyatt[27] discusses the cause of the formation of metallic soaps, gives methods for their measurement, and discusses their possible influence on the life of high-voltage cable insulation.

It is recognized that the combination, paper and oil, may be involved in the processes of instability. In this view not only chemical action, but physical conditions and changes are possible factors. Recent work of F. M. Clark[32] on the effect of chemical variations in the impregnating oils on the stability of impregnated paper bears on this question. Gaseous ionization is known to be an important deteriorating agent, supposedly through changes in the oil due to ionic bombardment. It is not always possible, however, to account for gas pockets or bubbles in well-impregnated insulation. L. J. Berberich[28] reports an experimental search made for addition agents which would reduce the large gas evolution under ionic bombardment from paraffinic oils which normally possess high oxidation stability. Aromatic compounds, when added to the oil, were found to reduce markedly the gas evolution. It is suggested that hydrogenation of the addition compounds takes place.

Solids

BREAKDOWN

Several noteworthy papers indicate increasing control of conditions, permitting deeper studies of the mechanism of breakdown. F. Lehmhaus[29] studies impulse breakdown in a number of solids under conditions ensuring that failure occurs during the rise of voltage in the wave front, the steepness of which is varied and measured. He analyzes the typical impulse voltage-time curves reported by Montsinger, Bellaschi, and others, concluding that there are three types of breakdown as follows: (1) thermal breakdown for time intervals greater than 10^{-2} second, and for which the usual falling voltage-time curve is typical; this is also the region of electrolytic conductivity; (2) breakdown within time intervals 10^{-2}, 10^{-7} second, so-called "electric breakdown" due to ionization by collision from electrons out of the electrodes or by ions of the material—liberation of heat no longer possible due to the short time; independent of temperature; (3) disruptive breakdown, time intervals less than 10^{-8} second—region of mechanical disruption under the electric field; ionization by collision no longer possible on account of the short time; independent of impurities.

P. Böning[30,31] extends his theory of the adsorption of ions on internal surfaces of the medium, one type of ion being liberated at very much lower stress than the other, thus leading to the accumulation of space charge and nonuniform distribution of potential gradient. The elements entering are the initial field strength necessary to liberate the mobile ions, the number of adsorbed ions, and the internal frictional resistance opposing the movement of the mobile ions. In two papers the author discusses the influence of temperature and of time on breakdown, using the experimental results of a number of other workers on rubber, glass, and other materials. The author claims agreement in the matter of temperature except for marked variations as the thickness of the sample is varied. In the matter of time, departures from the theory were found for values less than 10^{-4} second. F. M. Clark[32] studies the effect of variations of mineral oils in the matters of oxidation, refinement, and other chemical characteristics on the stability of impregnated paper. He concludes that the usual beaker oxidation test for oil is not reliable and suggests desirable degrees of olefinic and aromatic constituents for greatest stability. Behavior is determined by the nature of the oxidation product rather than by the quantitative proportions of oxidation. Of particular interest is the conclusion that there is a relation between the chemical changes in the impregnant and the nature and value of the voltage applied. B. Gänger[33] studies the influence of wave form on breakdown of a number of materials, and finds for most of them a decrease in breakdown voltage with increasing value of time of application for both peaked and flat-topped waves. An exception is dry cable paper for which he finds a practically constant breakdown voltage for all values of time up to 25 minutes. He attributes the different behavior of impregnated materials to the greater dielectric loss and consequent thermal, as distinguished from electric, breakdown.

DIELECTRIC LOSS AND PHASE DIFFERENCE

The nature of dielectric absorption and other causes of dielectric loss continues to attract widespread interest. The usual bases of discussion are the equation of the anomalous charging-current curve, with particular reference to its initial stages, its incorporation into and the evaluation of the von Schweidler integrals for loss and power factor, and the behavior of capacitance-resistance networks giving approximate equivalence to anomalous dielectric behavior.

P. Böning[34] presents an interesting analysis of the behavior of two capacitances in series, each shunted by its own resistance. He finds that for this combination all of the usual characteristics of an absorptive dielectric may be expressed as functions of the slope of the initial tangent to the residual voltage recovery curve, following brief short circuit after long-time charge. He states that this curve can be determined very much more easily in experiment than the usual short-time curve of charging current, and that consequently a more convenient and accurate method is available for d-c a-c correlation. No experiments in confirmation are reported, but are promised for a later paper.

S. O. Morgan[35] discusses the similarity of the equations of frequency variation of dielectric constant and loss for any type of dielectric polarization with those of the Debye type for molecular polarization. Curves are given for pure polar liquids and solids and for commercial insulating liquids illustrating the effect of chemical structure and the behavior of loss factor for different types of transition from liquid to solid state.

An excellent discussion of the physics of dielectric loss is found in the work of P. O. Schupp.[36] He discusses particularly the behavior of various capacitance-conductance combinations, and comparison with the Maxwell-Wagner two-layer capacitor, in the light of the varying physical properties of different materials. Explanation is offered of the unusually low dielectric losses in the new types of ceramic materials including those of recent type containing titanium dioxide; also the very slow changes over a wide frequency range of dielectric constant for resinous substances. Recognizing the similarity between the Maxwell-Wagner and Debye behavior for loss angle and dielectric constant to those of similar combinations of capacitances and conductances, he points to the difficulty of distinguishing among the several phenomena involved. As one means of distinction, he notes that the viscosity is an essential factor in Debye behavior, but does not enter into that of the Wagner model of conducting spheres in a dielectric medium. Among other papers F. Borgnis[37] proposes a new equation for the reversible absorption current-time curve, for which he finds certain advantages in the computation of the resulting dielectric loss. B. Gross[38] presents a number of experimental curves on vulcanized rubber under various programs of continuous voltage charge and discharge, examining some in the light of a theoretical discussion in which he proposes new formulas for the integrated effects, and finding close agreement of theory and experiment. E. Hippauf and R. Stein[39] take a number of short-time charging current-time curves on several solids and liquids, using the Whitehead amplifier oscillograph method, using, however, a rotating contactor instead of a quick-acting switch. Within the range from 0.004 to 0.2 second the charging current is found to vary closely as an inverse power of the time. J. Skanavi[40] examines experimentally the dielectric properties of glass containing different types and quantities of metallic ions. He finds certain variations in dielectric losses at high frequency, which he suggests has three components, structural, relaxation, and conduction. The relaxation component predominates and the metallic ions increase the conduction component and decrease the relaxation component. The polarization is chiefly ionic. The effect of crystallization is discussed with explanatory discussion. H. Höfer[41] reports mixtures of hydrocarbon materials and small amounts of mineral substances, having high dielectric constants as follows: d-c ballistic 115, 50 cycles 33.3, 750 cycles, 19.3; breakdown strength up to 100 kv per centimeter, specific resistance 10^9 ohms.

Dielectric Constant

There has been the usual extensive literature reporting the results of studies on dielectric constant. Much of this derives from studies on pure liquids with controlled admixtures and is in the field of basic physics and chemistry. There is thus a steadily accumulating store of correlative information between molecular structure and polar and other dielectric properties. No effort is made in these reports to go further than to note the promise that studies of this character must ultimately lead to wider knowledge and better control of the dielectrics of practice. More conspicuous from the standpoint of the properties of dielectrics as insulation are the increasing instances of high values of dielectric constant in some liquids, but more particularly in solids. The old picture of a single value of dielectric constant for a particular material has long since disappeared. The study of anomalous dispersion, that is, the variation of dielectric constant with frequency over the entire available range of the latter, has thrown much new light on the mechanism of dielectric constant. Four different types of polarization are recognized: the electronic, in which the motion of electrons within the atoms is involved; the atomic, in which the motion of the atom or ion within the molecule is the active agent; the polar property of the molecule itself, as pictured and developed in the Debye theory; and finally, the absorptive or interfacial polarization due to lack of homogeneity in the material as pictured by Maxwell. The first two types contribute to the dielectric constant uniformly at all power and radio frequencies. The other two may vary widely within the range of available frequencies, may occur simultaneously, and in general account for the variations of dielectric constant over the ranges of frequency and temperature as observed in practice. F. C. Frank[42] makes an analytical study of the causes of high dielectric constant, based on the Clausius-Mosotti formula, and further knowledge now available of the atomic and molecular structure of a wide variety of substances. He points out that the Clausius-Mosotti theory, as extended by Lorenz and Lorentz, automatically leads to a very great disparity among the materials of largest dielectric constant, so that the occurrence of a few materials with dielectric constants greater than 100 (while the value for the vast majority is less than 10) is less in need of special explanation than might at first appear. He notes that the temperature coefficient of dielectric constant and the incidence of electronic semiconduction limits the usefulness of many solids of high dielectric constant, much as electrolytic conduction limits that of liquids. The largest values of dielectric constant mentioned were those for liquid HCN, 194 and liquid HF, 175, in which the dipole is near the center of the nearly spherical molecule, which reduces the interaction between dipoles. In certain crystals dipole interaction may be added owing to the fact that the centers are held in special position. The extreme case mentioned is Rochelle salt, in which values of dielectric constants up to 15,000 have been measured. E. J. Murphy and S. O. Morgan[43] present an excellent qualitative review on the dielectric properties of insulating materials, in which the several types of polarization are reviewed, and where possible with special reference to the molecular structure of the material.

High-Voltage Cables

The literature on power cables for high voltage does not record any outstanding new development, but contains a great deal of interest in the matters of experience with existing designs, the use of new materials, new methods of test, and measures for protection. In a series of three papers presented on the same occasion to the Association of Swiss Engineers, P. E. Schneeberger,[44] J. Borel,[45] and E. Foretay[46] present a very interesting picture of cable engineering in general, cables for high and very high voltage, and the testing of electric cables, all with particular reference to European practice. While these papers are for the most part general surveys of current theory and practice, they contain a number of matters of interest to the American reader. A discussion of power cables for continuous voltage states that the dielectric strength of such cables is two and a half times as great as under alternating voltage, and gives a formula showing a rapid decrease in maximum voltage with increase of load due to increasing temperature. A description is given of the Cortaillod oil-filled cable in which the conductor is of type *HH* construction. Another similar and more extensive series of articles is published by *The Engineer* (London)[47] in which both description and discussion take their departure from British practice, and cover the several types of pressure and cushion cables developed in England for restricting gaseous ionization. C. A. Grover[48] discusses the feeding of oil to an oil-filled cable, with a detailed development of a method which permits a computation of pressure conditions resulting from temperature variations through the cable and at the feeding points, due to load variations. The Callender Company has described a single-conductor impregnated gas-pressure cable with rating of 200 kv; conductor cross section, 420 square millimeters, thickness of insulation 23.6 millimeters. A small space is left between the impregnated-paper insulation and the lead sheath. This space is filled after assembly with dry nitrogen at 14 atmospheres excess pressure, the lead sheath being heavily reinforced with copper tape. The impregnated insulation is directly exposed to the nitrogen. Pressure tanks are not necessary for any cable lengths at present in view. Details are given of a successful long-time test with heat cycles up to 60 degrees at 260 kv. A. N. Arman[49] describes the gas-impregnated cable for extra-high-voltage service in which thoroughly dried paper is used without impregnant, but filled with gas at 200 pounds per square inch. Careful studies are reported of the stress at which gaseous ionization begins and as related to different grades of paper. It is stated that either nitrogen or carbon dioxide are the best gases and that the internal ionization stress in these circumstances is about 200 kv per centimeter. Breakdown voltage-time curves are presented indicating a constant long-time value between parallel plates of 150 kv per centimeter, and on the cable sample of 115 kv per centimeter after 100 hours, and 111 kv per centimeter, after 236 hours. A necessary feature is the covering of the stranded conductor with a smooth surface, so as to avoid high stresses on the surfaces of the strands. Long-time stability tests up to 100 days with temperature cycles between 20 degrees and 80 degrees with relatively little change in power factor are reported. This is not a pressure cable in the ordinary sense. The high pressure does not serve to compress the paper structure, but only to increase the pressure of the contained gas which ultimately equalizes itself throughout by penetration through the openings in the paper.

Several matters of interest are reported in the field of cable accessories and test methods. J. K. Webb[50] describes further study and development of the condenser cone as applied to cable ends, bushings, and joints. As described, the cone is in effect a series of coaxial capacitors drawn out axially so as to form a cone. By the series connection of the several capacitors, the stress is uniformly distributed between the end of the cable sheath and the exposed high-voltage end of the cable, which is connected to the outermost electrode of the outermost capacitor. The cable end is, in fact, a cylindrical metallic cap, fitting over the end of the cone. W. E. Laycock[51] describes a method for determining inequalities in the lead sheath, which depends on the change in the inductance of a coil, partially surrounded by iron, when the open part of the magnetic circuit is closed by sheath lead. The change in the inductance of the coil by the presence of the lead is a function of the frequency, and passes through a maximum of about 25 per cent at 1,400 cycles, for the ordinary range of thicknesses of the lead sheath. Two such inductances are applied at opposite sides of the cable and connected in a bridge circuit. Variations in thickness are reflected in differences in the electromagnetic reaction in the two coils. Finished equipment contains two pairs of such coils at right angles and arranged for progressive motion along the cable. S. Basile[52] reports a method for eliminating or reducing the loss due to the currents induced in the lead sheath of single-phase underground cables. In place of the usual insulating joints, he proposes series or current transformers at regular intervals, whose secondaries are connected to capacitors. This permits a variation of the phase of the resultant flux set up in the core of a transformer and a consequent shift in phase of an electromotive force induced in the lead sheath. The analysis shows that these electromotive forces may offset in considerable measure the electromotive force lengthwise of the sheath due to the flux of the main field of the cable. The computations indicate a substantial reduction in loss in a particular case. E. Widl[53] reports a new a-c method for the location of failures in power cables, calling attention to the great inaccuracies inherent in present methods. He develops a full set of equations for the four-pole network, consisting of the two sections of undisturbed cable, and in between, the series and shunt resistances of the fault itself. In a special theorem of four-pole theory, the three sets of equations are combined. The method involves a knowledge of the values of the usual constants per unit length for the good cable, and d-c measurement of resistance (*a*) from sending end with far end open, (*b*) from far end with near end open, (*c*) from near end with far end short-circuited. Special treatment is necessary for certain differences among these values. Four examples are given showing excellent agreement between computed and measured distances. Karl Buss[54] reports a new type of impulse generator for cable testing, which consists of an air transformer with two sets of six coaxial cylindrical high-voltage coils. These coils all stand on open circuit throughout the alternating cycle, except at the point of maximum voltage, when they are momentarily connected in series and to the external capacitance by means of a needle-point synchronously rotating contactor. Another feature is the use of high-voltage cable as external capacitance. Great simplification is claimed by reason of the high transformer voltage, 700 kv, and the use of only two separate capacitors with only one series connection to make. It is stated that as external capacitance a standard 50-kv cable stands 700 kv continuous voltage without difficulty. The condition presented by the distributed nature of the external capacitance is analyzed, and the conclusions are checked by a cathode-ray oscillograph included as an integral part of the equipment.

K. Neuroth[55] presents an analytical study of the protective value of a high-voltage cable connecting a transmission line with a station. A high-voltage impulse with steep wave front is assumed. The resultant reflected and transmitted waves in the cable and in line beyond a substation are computed in the conventional manner. The resulting expressions involve the wave resistances of the line, the cable, and the wiring equipment within the station. The value of the energy which may be absorbed in the cable is computed, leading to a study by an approximation of the protective value of the cable. This latter may vary widely, as dependent on the relative insulation values on line and in station. Figures are deduced for the magnitude of the overvoltage as related to the length of the cable, utilizing the numerical values as known to occur in practice.

New Insulating Materials

Of outstanding interest during the past year, as indicated by an extensive literature, is the progress in the development of new insulating materials of both plastic and ceramic types. Especially noteworthy is the range of physical properties available in several new plastic materials. Since classification, co-ordination, and complete information are impossible at this stage, comment must be limited to a few outstanding examples.

STYRENE

Conspicuous among the new plastics are the various polymerized forms of monomeric styrol. Several papers have appeared on the applications of styrene, but special interest attaches to a series by T. R. Scott and J. K. Webb.[56–59] They have investigated the chemical-physical processing treatments to which styrene is susceptible, with resulting adaptations as an insulator for a wide variety of processes. They have studied the successive stages in the transformation of monomeric styrene to the solid polymeric form and have developed methods for inhibition, retardation, acceleration, and the use of plasticizers. Of special interest is the control of the induction period of polymerization and the rate at which the latter takes place. This has permitted the pre-impregnation of paper tape with the monomer, with certain admixtures preventing the sticking of the tape in rolls, polymerization being effected after application, for example, in a cable joint. Methods of construction of styrol stop joints and terminals in impregnated-paper cables, making use of these methods of control, are also described. They propose the possible use of styrene instead of oil as a saturant for high-voltage paper cables and promise a further paper on this subject. Papers of interest in the United States and on the same subject are that by L. A. Matheson,[60] presented at the recent meeting of the committee on chemistry of National Research Council, and that by K. S. Wyatt reported to the NRC conference in 1937, on cable wafers as a method of study of cable uniformity.

RUBBER

Recent improvements in artificial rubber are well described by M. G. Genin[61] together with a brief history of the research in this field, and a discussion in considerable detail of the differences in the methods of preparation of artificial rubber in the United States, in Germany, and in Russia. Particular attention is given to the various grades of Buna, the German product, and of Neoprene, the American product. There is a considerable range of variation of electric properties. Dielectric constant of natural rubber is given as 2.4 and of Neoprene, 6.9, with higher values in mixtures; on the converse, certain grades of Buna have values lower than that of natural rubber. Power-factor values of all synthetic rubbers are generally higher than those of natural rubber (0.005 to 0.015) with the exception of two grades of Buna which are said to have lower values. Further information, particularly as to synthetic Buna is given by H. Roelig,[62] who, in a number of tables and curves, reports electrical and mechanical properties, such as permanent change after loading, decrease of weight, resistance to tearing after storage in benzene, increase of weight in water, permeability to water, to water vapor, and resistance to benzene. The comparative tests indicate a number of advantages over natural rubber. This German writer states that the vulcanized synthetic rubber, Buna S. and Perbunan are replacing natural rubber in all movable conductors, in high-voltage rubber-insulated conductors, in waterproof insulated wiring, and in many other cases, all principally due to better mechanical properties. Thermoplastic synthetic rubber materials are replacing fibrous insulating materials in a number of services. Disadvantages noted are the narrow temperature range and the low insulation resistance. H. A. Morss, Jr.,[63] attempts an X-ray study of stretched rubber in an effort to find the true unit cell. While not successful in this, he obtains evidence of the configuration of the molecule and the location of atoms in the molecular chain.

RESINS

The October 1936 issue of *Modern Plastics* contains an excellent review of the various classes of synthetic resins, together with their electrical and physical properties. The groups are phenol formaldehyde, urea formaldehyde, furfural formaldehyde, cellulose acetate, cellulose nitrate, ethyl cellulose, vinyl resins, casein, acrylic, and cumarone; polystyrene and synthetic rubber are also discussed at considerable length. The methods of manufacture are briefly explained and some of their properties described. The extensive table of properties checked by the Bureau of Standards is particularly noteworthy. Those of special interest in the present connection are water adsorption, heat resistance, breakdown voltage, dielectric constant, power factor, and softening point. H. Burmeister[64] presents a descriptive review of various plastic materials developed since the appearance of bakelite and not including rubber. Some 13 materials are listed, mostly synthetic resins with and without inorganic fillers. Similar papers are presented by L. E. Barringer[65] and by

L. Hartshorn, J. L. Megson, and E. Rushton.[66] *Chemical and Metallurgical Engineering* enumerates approximately 800 new trade names for resin offered as insulation since November 1934. It is highly desirable that some form of conference and co-operation be brought about between chemist, manufacturer, and electrical user so that this vast array of new materials may be sifted, co-ordinated, and separated into groups suitable for particular purposes. Other studies on the adaptation of new materials to insulating purposes are those of M. L. Stoljarow[67] and Alfred Schädlich[68] on cellulose and Cellophane, and P. Nowak and H. Hofmeier[69] on the polyvinal chlorides as modified by fillers and plasticizers. A pulverized magnesium compound, said to be noncombustible, is reported by J. Bethenod.[70] It is compressed to a final solid, but flexible, state about the conductor. So far, it is available for cables up to 2,000-volt service. The various forms and uses of the new flexible insulation made of glass fiber are described by K. N. Mathes[71] and R. Hagner.[72] V. R. Vieweg[73] has published a volume on electrotechnical insulating materials from the standpoint of manufacture, use, and measurement, and presumably reflecting German practice.

Ceramics

Many new ceramic materials have also appeared. New developments in ceramics for insulation are confined principally to those for radio service. Among those now being used are magnesium silicate, glass, glass-bound mica, fused quartz, magnesia, and alumina. All these materials have been introduced as insulators to meet the demand for low dielectric losses in the high-frequency range. The plastics, some of which have been described hereinbefore, are used only up to the middle range of frequencies. In general the ceramics all have to be tooled and formed before firing for the final rigid state. An exception appears to be glass-bound mica which may be tooled after firing. Good descriptions of some of these materials and their properties will be found in an article in *Electronics*, February 1937. Other interesting data on titanium dioxide ceramics with high dielectric constant are presented by P. R. Coursey[74] with special reference to changes due to temperature.

Porcelain

Porcelain as a high-voltage line insulator is highly developed, but continues an interesting subject for study and further development. From Germany[75] comes description of an insulator for service up to 150 kv, consisting of a long porcelain rod with suitable hardware and screens on the ends, being a development of the insulator proposed by A. Schwaiger some years ago. The chief advantage claimed is in the saving in weight and in hardware. W. Schmidt[76] reports the results of combined electric and mechanical stresses on insulator porcelain. A somewhat lower damping coefficient in vibration is found. Breakdown voltage is lowered only in the neighborhood of mechanical failure. P. McAuley[77] reports impulse breakdown tests on standard rod gaps, suspension and pin type insulators, both wet and dry, under opposite polarities, and with corrections for humidity. B. Koske[78] reports a new method of testing line insulators while in operation. He uses the high-frequency field or "ground field" of the line. The radiation is greatest opposite the towers and increases with any defect in the insulator. It is stated that the test requires only one minute per tower, and is both accurate and time-saving. A. Schwaiger[79] presents an analytical study on the lightning vulnerability of transmission lines, deducing the relative probability with which a lightning stroke will strike the overhead ground wire, the line itself, or the line conductors as placed in various positions. The fundamental assumption is that preliminary ionization and space-charge accumulation result in bringing the leader stroke to a level relatively near to the earth's surface, and that transition from leader stroke to complete discharge takes place from this plane to the nearer structure at earth potential. The conclusion is reached that with a single ground wire, of the total vulnerability, the tower itself has only 3 per cent, the single earth wire 17 per cent, and the most vulnerable conductor from 46 to 80 per cent according to location. Analyzing the results of lightning strokes on a large number of lines, the author claims a high degree of accuracy for his method of computation.

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Of Institute and Related Activities

Enlarged Program for the 1939 Winter Convention

A PROGRAM comprised of some of the latest technical developments in many fields, yet not without social activities, has been arranged for the 1939 AIEE winter convention, which will be held in New York, N. Y., January 23–27, with headquarters in the Engineering Societies Building. Seventeen technical sessions, two general sessions, and seven technical conferences will be held during the mornings and afternoons, while in the evenings the smoker, Edison and John Fritz Medal presentations, and a dinner-dance will be held. In addition, a committee under the chairmanship of Mrs. A. F. Dixon is making arrangements for the entertainment of the women guests and the inspection trips committee will make arrangements to visit interesting places. As in the past, a post-convention cruise to Bermuda may be taken.

Edison and John Fritz Medal Presentations

On Wednesday evening, January 25, both the Edison and the John Fritz Medals will be presented in the engineering auditorium. The Edison Medal was awarded to Doctor Dugald C. Jackson "for outstanding and inspiring leadership in engineering education and in the fields of generation and distribution of electric power." As announced in the December 1938 issue, the John Fritz Medal was awarded to Doctor F. B. Jewett "for vision and leadership in science, and for notable achievement in the furtherance of industrial research and development."

General Sessions

Two general sessions will be held during the convention. The first, which will deal with economic and social problems, is scheduled for Wednesday morning, January 25. After remarks by President Parker, the noted economist, Doctor Virgil Jordan, president of the National Industrial Conference Board, Inc., will give an address on the subject "Enterprise and Social Progress." At the conclusion of this address opportunity will be afforded to ask questions.

The second general session, scheduled for Thursday afternoon, January 26, will be devoted to consideration of the engineering conclusions which can be drawn from the experiences with the New England hurricane of September 21, 1938. The experiences of the railroads, power utilities, and telephone companies operating in the region affected by the storm will be given by executives, after which there will be a period for discussion.

Smoker

Another excellent smoker to be held again at the Hotel Commodore is in prospect for Tuesday evening, January 24. In view of the popularity of past smokers held at the Commodore nothing need be said regarding the facilities or the experienced staff which assure a pleasant evening in comfortable surroundings. As usual, there will be a supper and show. The seating will be at tables of ten with ample space to move around. Those planning to attend are urged to send their reservations to the AIEE Smoker Committee, 33 West 39th Street, New York, N. Y., at an early date. All tables will be reserved. Tickets will be $3.50 per person.

Dinner-Dance

This year, as in the past, the outstanding social event of the winter convention will be the dinner-dance and buffet supper. It will be held Thursday evening, January 26.

Unusually extensive facilities have been reserved for the festivities in the Hotel Roosevelt. Dinner will be served at 7 p.m. in the Hendrik Hudson Room, followed by dancing in the Grand Ballroom from 9:30 p.m. to 2 a.m. By this novel arrangement whereby separate rooms are used for the dinner and dance the committee hopes to please both those who wish to enjoy a leisurely dinner and those who prefer to begin dancing promptly. Music for dancing will start at exactly 9:30 p.m. regardless of the time required to serve the dinner.

The president of the Institute will receive members and their guests immediately after dinner.

In addition to the two splendid large rooms several smaller rooms adjacent to the Grand Ballroom are being made available for lounging, beverage service, and for the buffet supper which will be served between midnight and 2 a.m.

One unit of George Ellner's orchestra will provide soft music for the dinner while another plays melodious and rhythmic strains for dancing. Encores will be limited in order to allow a large number of dances during the evening.

Automobile parking facilities will be provided by the hotel at a nominal fee.

Arrangements for a special rate on rooms for those who wish to stay in town overnight or to dress before the dance have been made. For room reservations write or phone the hotel and mention the AIEE.

The prices for tickets are:

Dinner and dance	$5.00 per person
Dinner, dance, and buffet supper	6.50 per person
Dance and buffet supper	3.00 per person

Dinner reservation requests should be sent to AIEE Dinner-Dance Committee, 33 West 39th Street, New York, N. Y., checks being made payable to "Special Account, AIEE." All such requests should include names of guests and desired seating arrangements, taking into account the fact that there may be either eight or ten persons seated at each table. The committee re-

Summarized Schedule of Principal Events

(See separate program for women's entertainment)

Monday, January 23

9:00 a.m.	Registration
10:00 a.m.	Relays Selected subjects Conference on sound
2:00 p.m.	Protective devices Transportation Electronics and industrial power applications
4:00 p.m.	Conference on electronics

Tuesday, January 24

9:30 a.m.	Symposium on rating—I. Temperature limits of insulating materials Communication I Switching transients
2:00 p.m.	Symposium on rating—II. Motor testing methods Communication II Power generation Conference on definitions
6:30 p.m.	Smoker at the Commodore Hotel

Wednesday, January 25

10:00 a.m.	General session
2:00 p.m.	Symposium on rating—III. Principles of rating Transmission and distribution Electric welding Conference on network analysis and synthesis
8:15 p.m.	Edison and John Fritz Medal presentations

Thursday, January 26

9:30 a.m.	Cables Instruments and measurements Basic sciences Conference on teaching of communication engineering and electronics
2:00 p.m.	General session
7:00 p.m.	Dinner-dance at the Roosevelt Hotel

Friday, January 27

All day	Inspection trips

Saturday, January 28

3:00 p.m.	"Monarch of Bermuda" sails on post-convention cruise to Bermuda

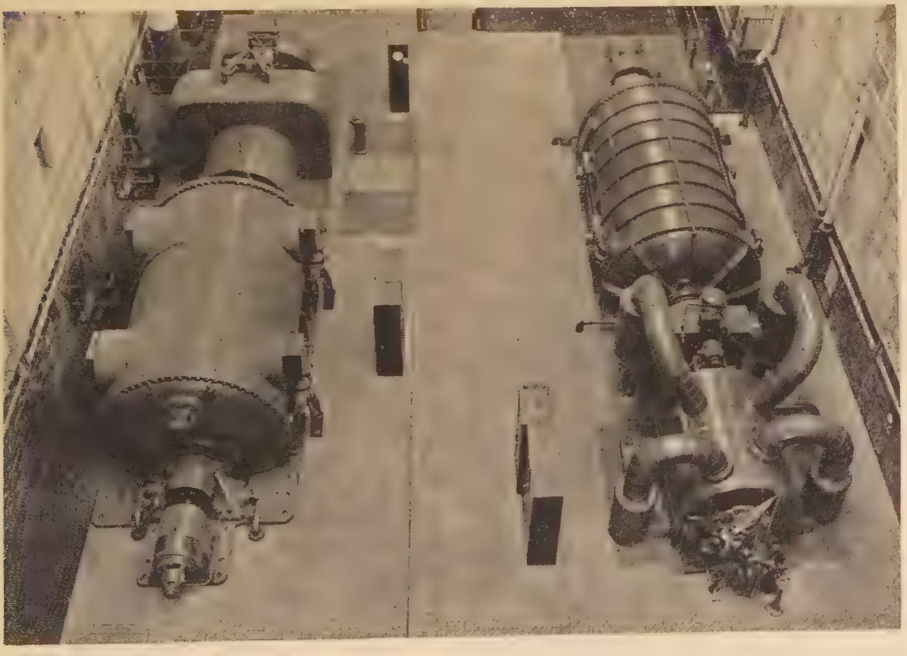
quests that tickets be purchased as early as possible so that there will be sufficient time to work out seating arrangements satisfactory to all.

TECHNICAL CONFERENCES

The programs for the technical conferences in connection with the symposium on the rating of electrical machinery and apparatus are outlined in detail with the technical program. As much information as is available at the date of going to press, in regard to the other technical conferences, is given herewith. In general, advance copies of conference papers are not available, although copies of some of these papers may be made available for distribution at the meetings by the authors.

Sound. In accordance with the custom of recent years, the AIEE subcommittee on sound will hold an informal conference to discuss recent developments in sound measurement and noise problems on Monday, January 23, on the first day of the winter convention. The agenda includes, first, a brief résumé of recent European developments in the technique of sound measurement and reduction by R. G. McCurdy of the Bell Telephone Laboratories, Inc. Mr. McCurdy has recently made a trip to Europe and discussed sound-measurement problems there with various leaders in this field.

Other subjects to be discussed are new data on the existing and desirable sound levels in various locations, the present situation in regard to sound-meter calibration, and the status of the various test codes for sound measurement. Suggested revisions of the proposed AIEE test code will be considered, and, if approved it is expected that this code will be subsequently published by the standards committee in final form. Test codes for transformers, fans, and other specific lines of apparatus are under development by various organizations, and the experts who are carrying on this work have been invited to present conclusions that they have reached.



Generators each rated 53,000 kw, 13.8 kv, 60 cycles, driven by "topping" turbines operating with steam at a pressure of 1,200 pounds per square inch and a temperature of 900 degrees Fahrenheit in Waterside No. 2 station of the Consolidated Edison Company of New York, which may be visited during the winter convention

Electronics. At the conclusion of the technical session on electronics the subcommittee will sponsor an informal conference on the subject under the chairmanship of Professor H. M. Turner.

Table I. A Few of the Hotels Available

Hotel	Location	Rooms With Private Bath	
		Single	Double
Ambassador	Park Avenue and 51st Street	$6.00– 8.00	$8.00–10.00
Astor	Broadway and 44th Street	3.50– 6.00	6.00– 8.00
Belmont Plaza	Lexington Avenue and 49th Street	3.50– 5.00	5.00– 7.00
Biltmore	Madison Avenue and 43d Street	6.00–12.00	8.00–14.00
Bristol*	129 West 48th Street	2.50– 5.00	3.50– 8.00
Commodore	Lexington Avenue and 42d Street	4.00– 6.00	6.00–10.00
Edison	228–248 West 47th Street	2.50– 5.00	4.00– 8.00
Governor Clinton	31st Street and 7th Avenue	3.00– 5.00	5.00– 7.00
Lexington	Lexington Avenue and 48th Street	4.00– 5.00	5.00– 7.00
Lincoln	Eighth Avenue and 44th Street	3.00– 4.50	4.00– 6.50
McAlpin	Broadway and 34th Street	3.00– 7.00	4.50– 9.00
Murray Hill	Park Avenue and 40th Street	2.50– 4.00	4.00– 6.00
New Yorker	8th Avenue and 34th Street	4.00– 8.00	6.00–10.00
Pennsylvania	7th Avenue and 32d Street	3.50– 6.00	5.00– 9.00
Plaza	Fifth Avenue and 59th Street	7.00–10.00	9.00–14.00
Roosevelt*	Madison Avenue and 45th Street	5.00– 9.00	7.00–12.00
Vanderbilt	Park Avenue and 34th Street	4.00– 5.00	6.00– 8.00
Waldorf-Astoria	Park Avenue and 50th Street	7.00–12.00	10.00–15.00

* See advertising section for further details pertaining to these hotels.

Definitions. To further the work on definitions of electrical terms the committee on basic sciences will sponsor a conference on definitions under the chairmanship of Professor M. G. Malti similar to the conferences which have been held during the past year.

Network Analysis and Synthesis. The committee on communication will sponsor a conference on this subject under the chairmanship of Professor Edward L. Bowles. Informal notices will be sent to those interested in this work and the program for the conference will be posted at the convention.

Teaching of Communication Engineering and Electronics. The committee on communication, in co-operation with the committee on education, will sponsor a conference on this subject under the chairmanship of Professor John R. Martin of the Case School of Applied Science.

WOMEN'S PROGRAM

In addition to the medal presentations on Wednesday evening and the dinner-dance on Thursday evening the women's entertainment committee has arranged the following series of events:

Monday, January 23

A.m. and p.m.—Registration.

Tuesday, January 24

12:45 p.m.—"The Cloisters." Meet at 33 West 39th Street for visit to the new Metropolitan Museum Cloisters built by John D. Rockefeller to house the beautiful French medieval collection started by George Gray Barnard.

4:30 p.m.—Reception and tea, British Empire Exhibition Room. Courtesy of Westinghouse.

7:30 p.m.—Consolidated Edison broadcast.

Wednesday, January 25

12:30 p.m.—Reception, West Ballroom, Hotel Commodore. Reception line: Mesdames Parker, Henline, Powell, Sutherland, Barton, and Farmer.

1:00 p.m.—Luncheon, West Ballroom, Hotel Commodore.

2:15 p.m.—Fashion Show, West Ballroom, Hotel Commodore.

3:00 p.m.—Bridge, West Ballroom, Hotel Commodore.

Thursday, January 26

11–11:30 a.m.—2:00 p.m.—Tours to Jules Bache home, 814 Fifth Avenue.

The board of governors of the Engineering Woman's Club extends the courtesies of the club to all attending the annual meeting. It is located at 126 East 35th Street, New York. Luncheon $.65, dinner $1.35.

INSPECTION TRIPS

The inspection-trips committee is making arrangements to visit a number of places during the week of the convention and Friday will be devoted entirely to inspection trips. Among the places to be visited the following have been tentatively selected: modern newspaper plant, electrical testing laboratory, modern brewery, motion-picture studio, Columbia University laboratory and cyclotron, television demonstration, lamp factory, meter works, elevator factory, cable factory, sponsored radio broadcasts, and New York Stock Exchange.

Those taking the post-convention trip to Bermuda will sail from New York at 3:00 p.m., January 28. For full information about the cruise write to Leon V. Arnold, 36 Washington Square West, New York City, who is the cruise director for the Institute.

Hotels and Registration

Reservations for hotel accommodations should be made by writing directly to the hotel of your preference. A few of the hotels available are listed in table I. Members

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Technical Program

Photo-offset copies of authors' manuscripts, exclusive of addresses, may be obtained in advance of the convention by writing to the AIEE Order Department, 33 West 39th Street, New York, N. Y. Only numbered papers will be available in advance copy form. If ordered by mail, price 10¢ per copy; if purchased at Institute headquarters or at the convention, price 5¢ per copy. Coupon books in $1.00 and $5.00 denominations are available for those who wish to avoid remittance by check or otherwise. Most of the papers ultimately will be published in Electrical Engineering or the Transactions.

Monday, January 23

10:00 a.m.—Relays

39-15. High-Speed Relaying Experience and Practice, relay subcommittee

39-30. Induced Current in Parallel Circuits and Its Effect Upon Relays, **E. H. Bancker,** General Electric Company

39-19. Bus Protection, relay subcommittee, AIEE, and relay subject committee, EEI

39-31. Considerations in Applying Ratio Differential Relays for Bus Protection, **R. M. Smith** and **W. K. Sonnemann,** Westinghouse Electric and Manufacturing Company, and **G. B. Dodds,** Duquesne Light Company

10:00 a.m.—Selected Subjects

39-10. Breakdown Studies in Compressed Gases, **Alvin H. Howell,** Massachusetts Institute of Technology

39-32. Effect of Corona Discharge on Liquid Dielectrics, **Joseph Sticher** and **D. E. F. Thomas,** The Detroit Edison Company

39-33. Inductive Co-ordination With Series Sodium Highway Lighting Circuits, **H. E. Kent,** Edison Electric Institute, and **P. W. Blye,** Bell Telephone Laboratories, Inc.

39-12. An Automatic Voltage Regulator Without Moving Parts Employing Ferroresonance, **Palmer H. Craig,** Invex Corporation

10:00 a.m.—Conference on Sound

2:00 p.m.—Protective Devices

39-34. A New High-Capacity Air Breaker **L. R. Ludwig** and **G. G. Grissinger,** Westinghouse Electric and Manufacturing Company

39-35. High-Power "De-Ion" Air Circuit Breaker for Central Station Service, **R. C. Dickinson,** Westinghouse Electric and Manufacturing Company

39-36. Multiple-Grid Breakers for High-Voltage Service, **J. B. MacNeill** and **A. W. Hill,** Westinghouse Electric and Manufacturing Company

39-37. Operating Experience With Petersen Coils on 66-Kv System of Metropolitan Edison Company, **H. M. Rankin** and **R. E. Neidig,** Metropolitan Edison Company

39-64. Factors Affecting Arc Extinction on a Petersen-Coil System, **J. R. Eaton,** University of Wisconsin

2:00 p.m.—Transportation

39-27. Pennsylvania Railroad, New York-Washington-Harrisburg-Electrification, Relay Protection of Power-Supply System, **E. L. Harder,** Westinghouse Electric and Manufacturing Company

39-21. Study of the Performance of the 3,600-Horsepower New Haven Electric Locomotives, **Felix Konn** and **F. H. Craton,** General Electric Company

39-22. The Magnesium Copper Sulphide Rectifier Battery Charger for Railroad Passenger Cars, **C. A. Kotterman,** P. A. Mallory and Company, Inc.

39-38. Harmonics in the A-C Circuits of Grid-Controlled Rectifiers and Inverters, **R. D. Evans** and **H. N. Muller, Jr.,** Westinghouse Electric and Manufacturing Company

39-39. Ignitrons for the Transportation Industry, **J. H. Cox** and **G. F. Jones,** Westinghouse Electric and Manufacturing Company

39-11. Voltage Control of Mercury-Arc Rectifiers, **G. R. McDonald,** General Electric Company

2:00 p.m.—Electronics and Industrial Power Applications

39-40. An Electronic Control Circuit for Resistance Welders, **T. S. Gray** and **J. Breyer, Jr.,** Massachusetts Institute of Technology

39-20. The Permatron—A Magnetically-Controlled Industrial Tube, **W. P. Overbeck,** Raytheon Production Corporation

39-41. Cold-Cathode Gas-Filled Tubes as Circuit Elements, **S. B. Ingram,** Bell Telephone Laboratories, Inc.

39-42. Continuous Processing for Automobile Tire Fabrics, **G. E. Cassidy** and **W. A. Mosteller,** General Electric Company

39-43. Electric Drives for Supercalenders in Paper Mills, **Roscoe H. Smith,** Reliance Electric and Engineering Company

4:00 p.m.—Conference on Electronics

Tuesday, January 24

9:30 a.m.—Symposium on Rating of Electrical Machinery and Apparatus I—Temperature Limits of Insulating Materials

39-7. Temperature Aging Characteristics of Class-A Insulation, **J. J. Smith** and **J. A. Scott,** General Electric Company

39-16. Temperature Limits Set by Oil and Cellulose Insulation, **C. F. Hill,** Westinghouse Electric and Manufacturing Company

39-44. Fiber Glass—An Inorganic Insulation, **F. W. Atkinson,** Owens-Illinois Glass Company

Technical Conference

Temperature Limits and Characteristics of Mica as Used in Conjunction With Class-B Insulation, **R. H. Spry,** Mica Insulator Company

Temperature Limits and Characteristics of Asbestos as Applied to Class-B Insulation, **J. B. Rohrer,** Raybestos-Manhattan, Inc.

Asbestos and Fiber-Glass Magnet-Wire Insulation, **K. N. Mathes** and **H. J. Stewart,** General Electric Company

Formex—A New Magnet Wire, **Ralph Hall,** General Electric Company

9:30 a.m.—Communication I

39-45. Electromagnetic Horn Design, **L. J. Chu** and **W. L. Barrow,** Massachusetts Institute of Technology

39-28. Copper-Oxide Modulators in Carrier Telephone Systems, **R. S. Caruthers,** Bell Telephone Laboratories, Inc.

39-46. Polyphase Broadcasting, **John F. Byrne,** Collins Radio Company

39-47. The Role of the Ionosphere in Radio Wave Propagation, **J. H. Dellinger,** National Bureau of Standards

9:30 a.m.—Switching Transients

39-48. Power System Transients Caused by Switching and Faults, **R. D. Evans, A. C. Monteith,** and **R. L. Witzke,** Westinghouse Electric and Manufacturing Company

39-49. Power System Voltage Recovery Characteristics, **Harold A. Peterson,** General Electric Company

39-50. Effect of Restriking on Recovery Voltage, **C. Concordia** and **W. F. Skeats,** General Electric Company

39-51. Influence of Resistance on Switching Transients, **R. C. Van Sickle,** Westinghouse Electric and Manufacturing Company

39-52. Overvoltages During Power System Faults, **Edith Clarke, S. B. Crary,** and **H. A. Peterson,** General Electric Company

Presentation by title:

39-76. Equivalent Circuit of a Transformer to Switching Surges, **L. V. Bewley,** General Electric Company

2:00 p.m.—Symposium on Rating of Electrical Machinery and Apparatus II—Motor Testing Methods

39-5. Measurement of Temperature in General-Purpose Squirrel-Cage Induction Motors, **C. P. Potter,** Wagner Electric Corporation

39-3. Determination of Temperature Rise of Induction Motors, **E. R. Summers,** General Electric Company

39-4. Reverse Rotation Test for the Determination of Stray Load Loss in Induction Machines, **Theodore H. Morgan, William E. Brown,** and **Arthur J. Schumer,** Worcester Polytechnic Institute east of the Mississippi River who receive the mailed announcement of the winter convention should fill in and post promptly the mail registration card. This will permit badges to be made ready in advance of arrival and avoid congestion at the registration desk. There will be a registration fee of $2 for nonmembers with the exception of Enrolled Students of the Institute and the immediate families of members.

Winter Convention Committee

The personnel of the 1939 winter convention committee is as follows: T. F. Barton, chairman; G. E. Dean, E. E. Dorting, F. M. Farmer, L. C. Miller, H. S. Osborne, J. H. Pilkington, A. L. Powell, C. S. Purnell, George Sutherland, and W. W. Truran. The chairmen of the subcommittees completing the arrangements are: T. S. Bacon, dinner-dance; D. W. Taylor, smoker; R. F. Brower, inspection trips; and Mrs. A. F. Dixon, women's entertainment.

Technical Program—Continued

Conference Introducing Principles of Rating

Discussion of Proposed Transformer Standards, **R. T. Henry**, Buffalo, Niagara, and Eastern Power Corporation

38–122. Loading Transformers by Copper Temperature, **H. V. Putman** and **W. M. Dann**, Westinghouse Electric and Manufacturing Company

2:00 p.m.—Communication II

39–53. A 12-Channel Carrier Telephone System for Open-Wire Lines, **B. W. Kendall** and **H. A. Affel**, Bell Telephone Laboratories, Inc.

39–54. The Submarine Cable Plow, **C. S. Lawton**, The Western Union Telegraph Company

39–55. The Submarine Cable Depthometer, **Dale H. Nelson**, The Western Union Telegraph Company

39–56. Remote Control Tollboard, **Arthur Bessey Smith** and **Gilbert Sorber**, Associated Electric Laboratories, Inc.

39–57. Crossbar Dial Telephone Switching System, **F. J. Scudder** and **John N. Reynolds**, Bell Telephone Laboratories, Inc.

2:00 p.m.—Power Generation

39–58. Modernization of L Street Station Switch House, Boston Edison Company, **C. A. Corney** and **W. W. Edson**, Boston Edison Company

39–25. Reconstruction of Switching Facilities at Essex Generating Station, **D. W. Taylor**, Public Service Electric and Gas Company

39–24. Modernization of Switch-House Design, **A. M. de Bellis**, Consolidated Edison Company of New York, Inc.

39–26. Modernization of Switch-House Design, **H. E. Strang** and **W. M. Hanna**, General Electric Company

2:00 p.m.—Conference on Definitions

Wednesday, January 25

10:00 a.m.—General Session

Remarks by the president

Address: Enterprise and Social Progress, Doctor Virgil Jordan, president, National Industrial Conference Board, Inc.

Period for questions

2:00 p.m.—Symposium on Rating of Electrical Machinery and Apparatus III—Principles of Rating

39–6. The Rating of Electrical Machinery and Apparatus, **R. E. Hellmund**, Westinghouse Electric and Manufacturing Company

39–2. Rating of General-Purpose Induction Motors, **P. L. Alger** and **T. C. Johnson**, General Electric Company

39–17. Effects of Temperature on Mechanical Performance of Rotating Electrical Machinery, **C. Lynn**, Westinghouse Electric and Manufacturing Company

39–18. The Rating and Application of Motors and Refrigeration and Air Conditioning, **P. H. Rutherford**, General Motors Corporation

39–59. Duty Cycles and Motor Rating, **L. E. Hildebrand**, General Electric Company

2:00 p.m.—Power Transmission and Distribution

39–60. Lightning Performance of 110- to 165-Kv Transmission Lines, lightning and insulator subcommittee

39–61. Experience With Ultrahigh-Speed Reclosing of High-Voltage Transmission Lines, **Philip Sporn** and **C. A. Muller**, American Gas and Electric Service Corporation

39–62. Secondary Versus Primary Capacitors, **F. M. Starr**, General Electric Company

39–63. Capacitors and Automatic Boosters for Economical Correction of Voltage on Distribution Circuits, **Leonard M. Olmsted**, Duquesne Light Company

2:00 p.m.—Electric Welding

39–13. Predetermination of Temperatures in Resistance Welds, **Walter C. Johnson**, Princeton University

Lecture and movies—Construction of Continuous Rails by Electric Welding, **William Dalton**, General Electric Company

39–65. Simplified Precision Resistance Welder Control, **F. H. Roby**, Square D Company

39–66. Power Supply for Single-Phase Resistance Welders, **R. H. Wright**, Westinghouse Electric and Manufacturing Company

39–67. The Alternating-Current Arc Progresses, **C. J. Holslag**, Electric Arc Cutting and Welding Company

2:00 p.m.—Conference on Network Analysis and Synthesis

Thursday, January 26

9:30 a.m.—Cables

39–68. Notes on Emergency Ratings, **A. H. Kidder**, Philadelphia Electric Company

39–29. Load Ratings of Cable, **Herman Halperin**, Commonwealth Edison Company

39–69. Economical Loading of High-Voltage Cables Installed in Underground Subway Systems, **E. R. Thomas**, Consolidated Edison Company of New York, Inc.

39–70. Maximum Safe Operating Temperature for 15-Kv Paper-Insulated Cables, **C. W. Franklin** and **E. R. Thomas**, Consolidated Edison Company of New York, Inc.

39–71. Low-Gas-Pressure Cable, **G. B. Shanklin**, General Electric Company

9:30 a.m.—Instruments and Measurements

39–23. Sensitivity of the Four-Arm Bridge, **A. C. Seletzky** and **L. A. Zurcher**, Case School of Applied Science

39–73. An Automatic A-C Potentiometer and Its Applications to Nondestructive Testing of Insulating Equipment, **George Keinath**, consulting engineer

39–8. An Amplifier-Wattmeter Combination for the Accurate Measurement of Watts and Vars, **G. S. Brown** and **E. F. Cahoon**, Massachusetts Institute of Technology

39–74. Aluminum-Nickel-Cobalt Brake Magnets for Watt-Hour Meters, **Stanley Green**, Duncan Electric Manufacturing Company

39–72. Demand Meter Time Periods, **P. M. Lincoln**, Cornell University

9:30 a.m.—Basic Sciences

39–1. Current Distribution in a Rectangular Conductor, **John L. Daley**, Yale University

39–14. Subharmonics in Circuits Containing Iron-Cored Inductors—II, **Irven A. Travis**, University of Pennsylvania

39–75. The Generalized Solution for the Critical Conditions of the Ferroresonant Parallel Circuit, **William T. Thomson**, Kansas State College

Presentation by title:

39–9. Values of the Bessel Functions ber x and bei x and Their Derivatives, **H. B. Dwight**, Massachusetts Institute of Technology

9:30 a.m.—Conference on the Teaching of Communication Engineering and Electronics

2:00 p.m.—Experiences From the New England Hurricane of September 21, 1938

Introductory statement describing the storm and general property damage and loss of life. Speaker to be selected.

Experiences of the Railroads, **Sidney Withington**, electrical engineer, New York, New Haven, and Hartford Railroad Company

Experiences of Power Utilities in Long Island, **E. W. Doebler**, general operating manager, Long Island Lighting Company

Experiences of Power Utilities in Connecticut, **C. W. Brown**, director of engineering, The Connecticut Power Company

Experiences of Power Utilities in Other New England States, **T. H. Haines**, superintendent of transmission and distribution, Boston Edison Company

Experiences of the Telephone Companies, **W. H. Harrison**, vice-president, American Telephone and Telegraph Company

General discussion

AIEE Southern District Holds Third General Meeting, at Miami

UNDOUBTEDLY the "farthest south" of the general meetings of the Institute was the Southern District meeting held in Miami, Fla., November 28–30, 1938. Headquarters were at the Miami Biltmore Hotel, Coral Gables, where the facilities that were provided comfortably accommodated all technical sessions and major entertainment features. This was the third meeting to be held by the Southern District since District meetings were inaugurated in 1924. Average attendance at the five sessions, including the student session, was in excess of 100. Other attendance details may be noted in the accompanying tabulations.

A noteworthy feature, indicative of the current trend in District-meeting activities, was the high proportion of students that attended and took active part in the technical sessions and other activities. This group was widely representative of the entire Southern District.

Local inspection trips offered to supplement the technical program included visits to a unique indoor substation, recent underground installations featuring the latest type of network protectors and transformers, and the Lauderdale steam-electric station of the Florida Power and Light Company. The Pan-American Airway's terminal drew the largest proportion of sight-seers, the variety of other attractions serving to divide the crowd into small groups, each according to its interest. At least seven persons signed up for the post-meeting trip to Cuba. The formal entertainment program included a general luncheon addressed by President Bryan C. Hawks of the Florida Power and Light Company, a student banquet, and a bridge-luncheon for the women. Culmination of the entertainment program was the banquet and dance held Tuesday evening and attended by some 166 persons.

Analysis of Registration at Miami Meeting

Classification	Location			
	Florida Section	District 4*	Other Districts	Totals
Members	36	62	12	110
Students	14	82	—	96
Men guests	19	6	3	28
Women guests	12	9	3	24
Totals	81	159	18	258

* Outside of Florida.

E. S. LEE GIVES ILLUSTRATED LECTURE ON ELECTRICAL MEASUREMENTS

Feature of the opening session Monday morning was an illustrated talk delivered by Everett S. Lee, director of the General Electric Company's general-engineering laboratories at Schenectady, N. Y. In his talk "Measuring Electrically," Mr. Lee told again the story that he has told so effectively before many Sections and Student Branches of the Institute during the past three or four years, revealing something of the drama involved in the evolution of many present-day measuring and control devices, tracing the threads of development from the inception of an idea in the laboratory to the industrial application.

One of the three sessions was given over entirely to a general discussion centering primarily around engineering education. To start the discussion, a paper "Grading the Engineer's Job" was presented by R. H. Kirkwood of the Tennessee Valley Authority. This was followed by three addresses: "Modern Aspects of Engineering Education" by Dean Joseph Weil of the University of Florida; "The Southern Engineer Weighs New Problems of New Industry" by Editor Eugene O'Brien of the *Southern Power Journal;* and "The Business Man Looks on the Engineering Graduate" by Kendall Weiseger of the Southern Bell Telephone and Telegraph Company. Discussion of these related subjects from both the industrial and the academic point of view was so active that the session was prolonged. A closing note was thus expressed by a southern educator: "Liberalization of engineering curricula is splendid and necessary, *but* attention to the selection of proper personnel for instructors and administrators in engineering schools is of at least equal importance." The other two sessions were devoted to the presentation and discussion of nine technical papers.

Summary of Attendance at Southern District Meetings

Year	Location	Attendance
1938	Miami	258
1930	Louisville	300
1928	Atlanta	400

STUDENT ACTIVITIES

Sponsored by the University of Florida Student Branch, the annual Southern District student conference was held as a part of the District-meeting program. Preceded by a short business session under the chairmanship of Student Counselor E. F. Smith of the University of Florida, the student technical session was held in parallel with one of the regular technical sessions Monday afternoon under the chairmanship of Student Counselor T. F. Ball of the University of South Carolina. Among the ultimate results of the business session were the selection of Dean L. L. Patterson, student counselor at Mississippi State College as chairman of the Southern District's committee on student activities for the administrative year 1939–40, and the acceptance of the invitation of Mississippi State College to hold the District student conference at that school in 1940. Papers presented at the student technical session were as follows, in the order of their presentation:

A SEMITECHNICAL DISCUSSION ON THE DESIGN OF FLOODLIGHTING FOR FOOTBALL STADIA, **H. S. Gregory** and **A. L. Martin,** University of Florida, Gainesville.

THE ICONOSCOPE—THE TELEVISION CAMERA, **C. E. Bryan,** University of Louisville, Ky.

STRAY-LOAD LOSSES, **I. W. Brown,** Tulane University, New Orleans, La.

THE DEVELOPMENT OF A PRECISION STANDARD FOR CALIBRATING FREQUENCY METERS, **J. R. Huff,** University of Tennessee, Knoxville.

LOAD DISPATCHING, **C. E. Gambell,** University of Tennessee, Knoxville.

FLUORESCENCE—THE LIGHT OF THE FUTURE, **Kitty W. O'Brien,** University of Virginia, University.

Double feature of this program was the young woman engineering student, Miss Kitty W. O'Brien, and the fact that in a highly competitive field she won second prize for effective presentation of her paper before an audience of approximately 100 persons. First prize for effective presentation went to J. R. Huff.

Entertainment feature of the students' program was a "students' and counselors' banquet" held Tuesday evening, November 28, and attended by some 172 persons. Toastmaster of the evening was Doctor B. F. Ashe, president of the University of Miami. Feature speaker was the Honorable R. B. Terry, chairman of the Florida State Board of Control.

In his remarks, President Ashe sought to answer the proverbial students' question of how to get a foothold in professional life after graduation. He urged students to "use what you have to get what you want," emphasizing the personally disastrous results of standing aside and patiently waiting for "conditions" to change. He emphasized the often repeated fact that each generation has a tendency to consider that all the useful developments in the world have been completed, urging that there is "plenty of work for the present and coming generations of engineers," but warning that individual initiative, imagination, and perseverance are required for success.

Mr. Terry enlarged upon Carlisle's definition of man as being a "tool-using animal," to define an engineer as being "a man of creative or productive imagination." Citing briefly the results of the imaginative efforts of such historical figures as Watt, Faraday, Bell, Marconi, Davey, and Edison, Mr. Terry flung something of a stimulating challenge to engineering students and graduate engineers alike: "If a man lets his imagination be stifled by the pressure of his everyday work, he is perilously close to complete stagnation."

For the official student conference and business session, the records show that of the 17 AIEE Student Branches in the Southern District, 16 were represented by student chairmen or alternates, and that 15 of the 17 student counselors also were present, as follows:

Branch Chairmen and Alternates

E. H. Lindsey, Alabama Polytechnic Institute, Auburn.
P. N. Morgan, University of Alabama, University.
T. J. Byrum, Duke University, Durham, N. C.
J. H. Brundage, University of Florida, Gainesville.
W. D. Stroud, Georgia School of Technology, Atlanta.
D. C. Schafer, University of Kentucky, Lexington.
Charles Dusenbury, Louisiana State University, Baton Rouge.
C. E. Bryan, University of Louisville, Ky.
F. K. McNeel, Mississippi State College, State College.
E. J. Angelo, North Carolina State College, Raleigh.
F. L. Arndt, University of South Carolina, Columbia.
D. L. Whitehead, University of Tennessee, Knoxville.
T. W. Brown, Tulane University, New Orleans, La.
P. B. Baldwin, Virginia Military Institute, Lexington.
J. H. Wynn, Virginia Polytechnic Institute, Blacksburg.
D. R. Webb, University of Virginia, University.

Counselors

W. W. Hill, Alabama Polytechnic Institute, Auburn.
F. R. Maxwell, Jr., University of Alabama, University.
W. J. Seeley, Duke University, Durham, N. C.
E. F. Smith, University of Florida, Gainesville.
T. W. Fitzgerald, Georgia School of Technology, Atlanta.
E. A. Bureau, University of Kentucky, Lexington.
S. T. Fife, University of Louisville, Ky.
L. L. Patterson, Mississippi State College, State College.
R. S. Fouraker, North Carolina State College, Raleigh.
T. F. Ball, University of South Carolina, Columbia.
J. G. Tarboux, University of Tennessee, Knoxville.
C. W. Ricker, Tulane University, New Orleans, La.
J. S. Jamison, Virginia Military Institute, Lexington.
Claudius Lee, Virginia Polytechnic Institute, Blacksburg.
L. R. Quarles, University of Virginia, University.

District Executive Committee Meets

A luncheon meeting of the Southern District executive committee was held November 28. Among various matters of District business handled were the selection of Professor F. R. Maxwell of the University of Alabama as representative of the Southern District on the national nominating committee which is to meet during the forthcoming winter convention; and the selection of Past-Chairman (1937–38) E. E. George of the East Tennessee Section as nominee for AIEE vice-presidency from the Southern District for the 1939–41 term.

Requested to address the executive committee informally, President John C. Parker outlined some of the major operating problems of the Institute as a whole, emphasizing that the board of directors is promoting "all possible work that is of importance to local members and Section and Branch groups." He stated as the objective of his administration the enhancement of the value of the Institute to the individual member who is remote from headquarters. Dwelling briefly on the theme that members benefit by the Institute membership in proportion to the interest and effort that they put into Institute activities, President Parker pointed out that in addition to Branch, Section, and District officers, more than 500 members are participating in the work of the Institute's many different committees. He urged special effort on the part of local Institute officers toward providing "something for every member to do," mentioning the presentation and discussion of papers, administrative work, technical committee activities, and other possibilities.

Vice-President E. D. Wood pointed out that all but two members of the District executive committee were present for the meeting, and that those two had been detained by circumstances beyond their control. Those present were:

E. D. Wood, vice-president, AIEE.
A. S. Hoefflin, secretary, Southern District and chairman, Louisville Section.
E. F. Smith, chairman, District committee on student activities.
A. S. Anderson, vice-chairman, national membership committee.
F. R. Maxwell, Jr., chairman, Alabama Section.
T. H. Mawson, secretary, Alabama Section.
J. E. Housley, chairman, East Tennessee Section.
R. W. McEver, secretary, East Tennessee Section.
A. P. Michaels, chairman, Florida Section.
Joseph Weil, secretary, Florida Section.
H. G. Harvey, chairman, Georgia Section.
J. M. Flanigen, secretary, Georgia Section.
J. M. Houchens, secretary, Louisville Section.
C. M. McCord, chairman, Memphis Section.
E. J. Biegel, secretary, Memphis Section.
F. E. Bell, chairman, Muscle Shoals Section.
Miss M. G. Coyne, secretary, Muscle Shoals Section.
F. E. Johnson, secretary, New Orleans Section.
M. E. Lake, chairman, North Carolina Section.
J. S. Miller, chairman, Virginia Section.
F. W. Smith, secretary, Virginia Section.

In addition to the 21 voting members of the committee, visitors present included President J. C. Parker, National Secretary H. H. Henline, Editor G. R. Henninger, and Past Vice-President W. S. Rodman.

Miami Meeting Committee

The personnel of the committee responsible for the success of the Florida meeting under the direction of General Chairman A. P. Michaels of Orlando included Vice-President E. D. Wood of Louisville, Ky.; District Secretary A. S. Hoefflin, Louisville; E. F. Smith and Joseph Weil of Gainesville, Fla.; E. E. George of Chattanooga, Tenn.; E. F. Johnson, Miami; M. E. Lake, Charlotte, N. C.; and W. A. Smith of Jacksonville, Fla.

Chairmen of technical sessions were: A. S. Hoefflin, Tuesday morning; J. F. Miller, Jr., Tuesday afternoon; and H. G. Harvey, Wednesday morning.

of those who attended the recent AIEE Southern District Meeting at Miami, Fla.

AIEE Executive Committee Meets at Headquarters

A meeting of the executive committee of the American Institute of Electrical Engineers was held at Institute headquarters, New York, N. Y., on December 16, 1938, in place of the regular meeting of the board of directors.

Present: President John C. Parker (chairman), F. M. Farmer, W. H. Harrison, C. R. Jones, and K. B. McEachron, members of the committee; National Secretary H. H. Henline.

Reports of meetings of the board of examiners held November 17 and December 15, 1938, were presented and approved. Upon the recommendation of the board of examiners, the following actions were taken: 7 applicants were transferred and 8 were elected to the grade of Member; 72 applicants were elected to the grade of Associate; 362 Students were enrolled.

Upon recommendation of the standards committee, the executive committee approved for publication a revision of AIEE Standard No. 45, "Recommended Practice for Electrical Installations on Shipboard."

As recommended by the standards committee, the following appointments of Institute representatives were made: R. A. Beekman, representative, W. N. Zippler, alternate, on the Sectional Committee on Electrical Installations on Shipboard—*C*66, and H. W. Samson on the Sectional Committee on Drawing and Drafting Room Practice—*Z*14, succeeding T. G. Crawford.

Upon request of the San Francisco Section and recommendation of the Sections committee, authority was granted for the addition of the counties of Washoe, Ormsby, Storey, Lyon, Douglas, and Mineral in western Nevada to the territory of the San Francisco Section.

Authority was granted for the organization of a San Diego Section, with territory consisting of San Diego and Imperial Counties, California.

Upon recommendation of the Committee on Student Branches, the establishment of a Student Branch at the New Mexico State College of Agriculture and Mechanic Arts, State College, was authorized.

The finance committee reported expenditures amounting to $23,471.31 in November and $17,871.78 in December.

Other subjects were discussed, reference to which may be found in this or future issues of ELECTRICAL ENGINEERING.

Eta Kappa Nu Announces 1938 Awards

W. E. Kock of the Baldwin Piano Company, Cincinnati, Ohio, has been named by Eta Kappa Nu, honorary electrical engineering society, as the outstanding young electrical engineer for 1938. Mr. Kock was chosen from over 40 candidates nominated from every section of the United States by heads of college electrical-engineering departments and Sections of the AIEE. He becomes the third man to receive this honor. Two honorable-mention awards have also been announced for 1938, to be given to H. E. Gove (A'31) of the Union Electric Company of Missouri, St. Louis, and G. M. L. Sommerman (A'31, M'37) of the American Steel and Wire Company, Worcester, Mass.

The awards were made by a committee of prominent engineers: Chairman R. L. Sackett, dean emeritus, Pennsylvania State College; R. E. Doherty (A'16, M'27) president, Carnegie Institute of Technology; A. M. Dudley (A'08, F'13) Westinghouse Electric and Manufacturing Company; John C. Parker (A'04, F'12, president) vice-president, Consolidated Edison Company of New York, Inc.; William Wilson (M'23) vice-president, Bell Telephone Laboratories; and two past national officers of Eta Kappa Nu, Morris Buck (A'05, F'23) and M. S. Mason (M'31).

The Eta Kappa Nu Award which is for young engineers graduated not more than 10 years, and less than 35 years of age, was inaugurated 3 years ago to recognize "meritorious service in the interests of their fellowmen." It was believed that the careers of particularly successful engineers who were yet in their early thirties would act as valuable guides, and as inspiration for new graduates to take up their professional development without delay. Since an engineering education is presumed to prepare a man for a wide variety of achievements, particular attention was paid by the judges to all of the candidates' activities—technical civic, social, and cultural—in making the final selections.

The award dinner will be held in New York on Monday evening, January 23, 1939, the first day of the AIEE winter convention, in order to afford an opportunity for out-of-town members of the Institute to attend. Mr. Kock will receive a small replica of the large bronze bowl, upon which his name will be engraved, which is permanently displayed at AIEE headquarters in New York. Recipients of honorable mention will receive appropriate certificates.

Standards Association Holds Annual Meeting

Marking the 20th year of the American Standards Association activities as national clearing house for the standardization work of American industry, the annual meeting of the association was held at New York, N. Y., November 30, 1938. D. D. Barnum, retiring president of the association, welcomed six trade groups that have become members during the past year, and emphasized the international work in which the association is taking part. He also called attention to the 14 active projects in the building field, to the beginnings of work for the prevention of occupational diseases, and to the newly organized highway-traffic standards committee which is bringing together 17 national organizations and government groups interested in safety standards for traffic.

F. M. Farmer (A'02, F'13) vice-president of Electrical Testing Laboratories and chairman of the standards council of ASA, announced that during the year 21 new standards and 24 revisions of existing standards have been approved. Guest speaker at the meeting was W. L. Batt, president of SKF Industries, and president of the International Committee of Scientific Management. The following new officers of the ASA were elected:

President—E. A. Prentis, member of the firm of Spencer, White and Prentis, New York.

Vice-President—R. E. Zimmerman, vice-president, United States Steel Corporation.

Chairman, Standards Council—F. M. Farmer (A'02, F'13) vice-president, Electrical Testing Laboratories, New York (re-elected).

Vice-Chairman, Standards Council—R. P. Anderson, secretary, division of refining, American Petroleum Institute, New York (re-elected).

Future AIEE Meetings

Winter Convention
New York, N. Y., January 23–27,1939

South West District Meeting
Houston, Texas, April 17–19, 1939

North Eastern District Meeting
Springfield, Mass., May 3–5, 1939

Summer and Pacific Coast Convention (combined)
San Francisco, Calif., June 26–30,1939

Great Lakes District Meeting
Minneapolis, Minn., September 27–29, 1939

Middle Eastern District Meeting
Scranton, Pa., October 11–13, 1939

Four Sections Hold Joint Meeting

A joint meeting of the four AIEE Sections of Alabama, East Tennessee, Memphis, and Muscle Shoals was held in Huntsville, Ala., December 10, 1938, and was attended by 75 engineers, according to Margaret Coyne (A'37) secretary of the Muscle Shoals Section. A luncheon and inspection tour was held at the Guntersville Dam, and a smoker was held for the engineering students of Vanderbilt University, University of Alabama, University of Tennessee, and Alabama Polytechnic Institute.

An evening banquet and reception was held in honor of AIEE President John C. Parker; others present included Vice-President E. D. Wood, and Past Vice-President Mark Eldredge, who served as toastmaster.

ICI Committee Holds Annual Meeting

The United States National Committee of the International Commission on Illumination held its annual meeting at New York, N. Y., November 9, 1938. P. S. Millar (A'03, M'13) of the Electrical Testing Laboratories, New York, N. Y., was re-elected president; G. H. Stickney (A'04, F'24) East Orange, N. J., was re-elected secretary-treasurer; and A. A. Brainerd of the Philadelphia Electric Company, Philadelphia, Pa., was elected to the newly created office of executive secretary. Other members of the executive subcommittee are C. H. Sharp (A'02, F'12) A. C. Hardy, and E. C. Crittenden (A'19, M'22).

Plans were discussed for the forthcoming ICI meeting in Holland. Advance word from the various countries taking part in the international meeting indicates an exceptionally stimulating conference, with widely varied subjects covered.

AIEE Officers to Be Nominated Soon

In accordance with the Institute's by-laws, the national nominating committee of the AIEE will meet during the winter convention to be held in New York, N. Y., January 23–27, 1939, for the purpose of nominating national officers to be voted upon by the membership in the spring of 1939. Members of this year's national nominating committee are as follows:

Representing the Board of Directors

C. R. Beardsley, Consolidated Edison Company of New York, Inc., New York, N. Y.

F. M. Farmer, Electrical Testing Laboratories, New York, N. Y.

A. H. Lovell, University of Michigan, Ann Arbor.

C. A. Powel, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

R. W. Sorensen, California Institute of Technology, Pasadena.

Representing the Ten Geographical Districts

1—A. C. Stevens, General Electric Company, Schenectady, N. Y.

2—E. S. Fields, Cincinnati Gas and Electric Company, Cincinnati, Ohio.

3—A. L. Powell, Incandescent Lamp Department, General Electric Company, New York, N. Y.

4—F. R. Maxwell, Jr., University of Alabama, University.

5—T. G. LeClair, Commonwealth Edison Company, Chicago, Ill.

6—L. N. McClellan, United States Bureau of Reclamation, Denver, Colo.

7—J. B. Thomas, Texas Electric Service Company, Fort Worth.

8—C. A. Andrews, Westinghouse Electric and Manufacturing Company, San Francisco, Calif.

9—Obed C. Haycock, University of Utah, Salt Lake City.

10—M. J. McHenry, Hydro-Electric Power Commission of Ontario, Toronto, Ont., Canada (empowered to appoint his own alternate).

Alternate for any member of the board of directors: A. M. MacCutcheon, Reliance Electric and Engineering Company, Cleveland, Ohio.

Provisions of the AIEE constitution and by-laws relating to nominations were given in ELECTRICAL ENGINEERING for November 1938, page 462. In addition to those to be designated by the national nominating committee, nominations also may be made independently. Briefly, independent nominations may be made by a petition of 25 or more members sent to the national secretary at Institute headquarters, not later than March 25, to be placed before the nominating committee for inclusion in the ballot of such candidates as are eligible. Petitions for the nomination of vice-president may be signed only by members within the District concerned.

ASCE to Award Five Honorary Memberships

According to plans recently announced The American Society of Civil Engineers at its annual meeting in January 1939, will confer the award of honorary memberships on five of its veteran members and professional leaders. The men whose contributions to engineering will be so recognized are: Frank E. Weymouth, general manager and chief engineer, Metropolitan Water District of Southern California; Edward E. Wall, director of public utilities, St. Louis; C. Frank Allen, professor emeritus, Massachusetts Institute of Technology; Anson Marston, dean emeritus, school of engineering, Iowa State College; Arthur S. Tuttle, consulting engineer, New York.

Mr. Weymouth, in his sixty-fourth year, has behind him a long record of service on public projects prior to his present responsibility in connection with the development of Colorado River water supply for Southern California. This includes previous service with the City of Los Angeles and the U. S. Bureau of Reclamation. Mr. Wall, long active in society and association work, has, except for a brief period, been associated with the water or utilities departments of the City of St. Louis since 1890. Professor Allen is a retired professor of railroad engineering and an author of various books. Now in his eighty-seventh year, he was on the staff of Massachusetts Institute of Technology from 1887 to 1916 when he retired under the Carnegie Foundation to become professor emeritus. He has been widely active on public commissions and in various technical affairs. Dean Marston long has been active in ASCE affairs and is now senior dean of engineering at Iowa State College. Mr. Tuttle, although in his seventy-third year, is enormously active in association, social, and technical capacities in New York City. He is project engineer for the PWA on the Queens Midtown Tunnel, and has carried administrative responsibility since 1933 for the Federal Administration of Public Works both in New York City and State.

Electronics Standard Issued. A new standard on electronics has been issued by the Institute of Radio Engineers. Previous IRE standards have combined in a single document information on all phases of radio communication, electronics, and allied subjects; therefore, this new standard represents a departure from usual IRE practice, because it contains information restricted entirely to electronics. It is a revision of the vacuum-tube portion of the 1933 IRE standards. Section headings of the new standard include (1) definitions of terms, (2) symbols, and (3) methods of testing vacuum tubes. Copies may be secured from The Institute of Radio Engineers, Inc., 330 West 42d Street, New York, N. Y.

Subdivision of Cleveland Section Formed at Mansfield

More than 50 electrical engineers from Mansfield, Galion, and Ashland, Ohio, met December 5 to organize a Mansfield division of the Cleveland Section, to establish the objectives of the division, to settle organizational details, and to elect officers for the current term.

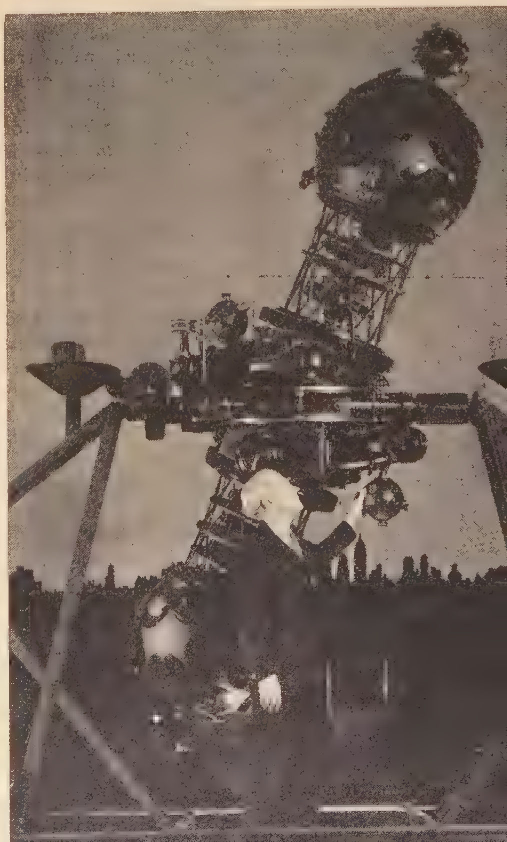
Starting the Mansfield division was the outgrowth of a move on the part of several AIEE members in the area to provide a means for more active participation in Institute affairs. Assigned to the Cleveland Section, members in Mansfield received notices of that Section's meetings, but the distance of 75 miles made attendance at more than from one to three meetings per year impossible. A similar distance problem existed for the members in Galion (assigned to the Toledo Section), in Ashland (Akron Section), and in Marion (Columbus Section).

A survey of the interest in a local division made two months ago showed that practically all of the members in the vicinity wanted an organization in Mansfield. The results of the survey were presented to the executive committee of the Cleveland Section in October, and that committee authorized the formation of a Mansfield division.

Prior to the organization meeting on December 5, questionnaires were distributed to all members, asking their opinions on the types of programs desired, preferred nights for meetings, and many other details. This plan greatly expedited the business of the organization meeting, and enabled the group to have a regular speaker for the first night.

Functions of the Mansfield division, as

Hayden Planetarium in New York City has been visited by many of those attending recent AIEE winter conventions. Here is shown the Zeiss projector which throws a picture of the sky above the New York skyline onto the interior of the dome, and Doctor Clyde Fisher, curator



decided at the meeting, are to inform members and any others who are interested concerning recent engineering developments, to serve as a co-ordinating influence for all types of engineers in the region, to provide counsel to prospective engineering students, and to promote in every possible way the interests of the Institute.

Meetings are scheduled for the first Wednesday of every month from October through May, with the exception of January when the second Wednesday will be the meeting date. Four meetings each season will be devoted to talks, two will consist of inspection trips followed by a talk on the point visited, one will be an open forum on a timely subject, and one will be a social evening. Talks will be mainly on engineering subjects, such as television, electronics, instruments and measurements, electrical protective devices, application of photocells, communication, and opportunities in the engineering profession.

Officers elected for the 1938–39 season were: chairman, Clifford A. Faust (A'35), advertising department, Ohio Brass Company, Mansfield; vice-chairman, Henry F. Herbig (A'23), research engineer, North Electric Manufacturing Company, Galion; chairman of attendance and publicity, William A Barnes (A'24), chief engineer, Dominion Electrical Manufacturing Company, Mansfield; and secretary-treasurer, Frank H. Milliken (A'33), design engineer, Ideal Electric & Manufacturing Company, Mansfield.

Basic Research Dominant in Papers Presented at NRC Insulation Conference

IN HIS annual report to the Conference on Electrical Insulation of National Research Council, presented at the eleventh annual meeting of the conference held recently in Pittsburgh, Pa., Chairman J. B. Whitehead (A'00, F'12) said that during the past year: "There have been perhaps fewer noteworthy developments in applications of new knowledge to the problems of insulation. However, basic research in the field of chemistry and physics has continued its attack upon the problems of atomic structure and molecular assemblage." (Full text of Doctor Whitehead's report appears elsewhere in this issue.) This trend toward fundamentals was reflected also in the 22 papers presented and discussed at the Pittsburgh meeting. Brief abstracts of these papers are given on this and following pages.

CHEMISTRY AND PHYSICS

The Influence of Thermal History on Polyvinyl Chloride Plastics—**R. M. Fuoss.** Polyvinyl chloride, plasticized with tricresyl phosphate, exhibits electrical properties that are influenced very markedly by the method of preparing the sample for electrical measurements. This behavior is due primarily to the pyrolysis of the polyvinyl chloride on exposure to high temperatures, but pyrolysis of the plasticizer also may contribute to the effect. In the first place, the d-c conductance obviously increases with increased thermal exposure. In the second place, the pure a-c response also is changed; the a-c absorption increases and the dielectric constant increases. Furthermore, the temperature and frequency coefficients of these quantities are changed. A thermally aged sample of plasticized polyvinyl chloride is really a three-component system rather than a two-component system, and its properties are those of a weak electrolyte in a plastic (two-component) solvent medium. The influence of thermal history can be summarized as follows: the conductance of a given sample at a given time depends on its entire previous thermal history; and in turn, all other electrical properties depend on the value of the d-c conductance.

Further Studies of Oil Deterioration—**J. C. Balsbaugh** (A'23, M'35), **J. L. Oncley,** and **A. H. Howell** (A'35). Two bridges and special testing apparatus and procedures have been developed to aid in studying oil deterioration. The first bridge will measure accurately small power factors on small samples over a range of frequencies, with voltages as low as 100 volts applied to the sample. The equal-ratio-arm bridge is so arranged that it can be operated as a Schering bridge (source symmetrical) or as a conjugate Schering bridge (detector symmetrical). The second bridge was built for making d-c conductivity measurements on small samples. Its outstanding feature is that the low voltage applied to the sample (down to one volt) permits measurements to be made before the measuring system itself causes the conductivity of the sample to change. A conductance as low as 10^{-15} mho can be measured. A spectrophotometer which measures the per cent transmission at all wave lengths in the visible spectrum has been used in the study of color of mineral oils. The wide and consistent variations that have been found give promise of yielding correlative results. The success of the Grignard apparatus and reagent has led to its continued use and improvement. The apparatus has been redesigned to make it easier to manipulate, more compact, and more accurate. An oxidation system has been constructed entirely of glass, including the pump which agitates the oil and sends a dispersion of gas through it.

Liquid Dielectrics—Some Electrical and Physical Properties of Systems Containing Sparingly Soluble Oxidation Products in Liquid Paraffin—**J. D. Piper, C. C. Smith** (A'29), **N. A. Kerstein,** and **A. G. Fleiger.** Various compounds, selected to represent types of sparingly soluble oxidation products such as may be formed by the service degradation of insulating oils, have been added to liquid paraffin which had a low power factor, and the resulting effect on the dielectric properties of the liquid paraffin determined. These compounds were added in such concentrations that the resulting systems appeared homogeneous at the higher temperatures employed, but heterogeneous at the lower temperatures. The systems fell into two classes depending upon whether the second phase which formed as the systems were cooled was liquid or solid. When the second phase was composed of droplets of a mobile, polar liquid, the power factor values increased greatly as the systems became heterogeneous. A liquid phase always formed first in the systems examined. The resulting systems had very high power factors but low d-c conductivities. Later a crystalline phase appeared, always from the external rather than from the internal phase of the emulsion. With crystal growth, the droplets forming the internal phase gradually disappeared and the power factor and dielectric constant dropped markedly, but the d-c conductivity increased. Of the systems in which the second phase was a solid, only three were found in which the formation of the second phase had any marked influence on the power factor of the system. In these three systems the added materials were cetyl, ceryl, and octadecyl alcohols. As the systems containing these alcohols became heterogeneous, the power factor and dielectric constant increased greatly.

Dielectric Constant and Viscosity of Resin Solutions—**Harold Hitchcox, Robert Pratt, H. C. Ott,** and **O. M. Arnold.** The viscosities, dielectric constants, densities, and refractive indexes of benzene solutions of polystyrene, vinylite, Abalyn, Hercolyn, and Petrex were determined at 25 degrees centigrade, and additional measurements were made on polystyrene and vinylite in ethylene dichloride. Dielectric dispersion was studied over a frequency range of 1 to 10,000 kilocycles. Concentrations of solutions investigated range from 0.1 to 41.2 grams of resin per hundred cubic centimeters. The dielectric dispersion of Abalyn and Hercolyn was measured on liquid resins as received. These two substances produced practically identical effects on the viscosity of benzene. The Einstein constant for vinylite and polystyrene in solutions increased rapidly with concentration indicating the entangling of large molecules. Abalyn, Hercolyn, and Petrex dissolved in benzene gave values of the Einstein constant which while varying with the concentration were less than five even in the case of the highest concentration. Values of Fikentscher's constant calculated from viscosity measurements, showed appreciable variation not only with concentration but also with the solvent used. Substitution of ethylene dichloride for benzene gave increased values of Fikentscher's constant for vinylite but showed a corresponding decrease for polystyrene. The insulating properties of polystyrene are reflected in its low dielectric constant and absence of appreciable dispersion. Dispersion of dielectric constant with frequency was noted in the case of vinylite, Abalyn, Hercolyn, and Petrex. Abalyn and Hercolyn apparently have high dielectric losses at the higher frequencies.

Cataphoresis in Insulating Media—**Andrew Gemant.** In a quantitative research into the cataphoresis of insulating liquids, which is known to play a certain role during processes occurring in transformer oil, there were chiefly two experimental problems to be solved: the preparation of suitable suspensions, and the finding of suitable methods for quantitative investigation. Synthetic resins were found to be suitable objects as the dispersed phase; those investigated were mainly polystyrene and methyl-methacrylate. The main principle of preparing the suspensions consists in the addition to solutions of these resins in benzene and similar insulating solvents of oils in which the resins are insoluble. It is possible to obtain suspensions that are stable for 24 hours or so. In some instances temperature conditions must be controlled very closely; in others certain stabilizers become necessary; but most important is the correct concentration of the components which is determined by experiment. As to method, the microscopic one was found most suitable for obtaining quantitative results. The results showed that the potential difference between the two phases, resin and oil, was of the order of 30 to 40 millivolts. The sign of the charge of the particles varied according to the special resin chosen; for polystyrene it was negative and for methyl-methacrylate, positive. The simultaneous occurrence of both positive and negative particles has not been observed with these two resins. Certain electrolytic admixtures seem to influence the magnitude of the charge in a characteristic way.

The Generation of Gases in Paper by Thermal Decomposition and by Electrolysis—**E. J. Murphy** and **G. T. Kohman.** The thermal decomposition of paper in an evacuated system yields water vapor, carbon dioxide, and carbon monoxide as gaseous products at temperatures of the order of 150 degrees centigrade. The rate of evolution of these gases decreases very slowly with time at a given temperature. The application of a d-c potential after the rate of thermal decomposition had been established, greatly increased the rate of evolution of gas. For example, when the paper was at a temperature of 160 degrees centigrade and the over-all voltage gradient about 300 kv per centimeter, the rate of evolution of gas with the field applied was about eight times as great as when the field was not applied. The possibility that the effect of the electric current was merely to increase the rate of thermal decomposition by raising the temperature of small regions of particularly high conductivity is excluded by the difference between the composition of the thermally produced gas and the gas produced by the current. The picture formed of the process involved is that of a hybrid process combining ordinary electrolysis with the bombardment of the surface of the paper and the molecules of any vapor or gas present by ions.

Electrical Characteristics of Ionized Gas Films—**C. L. Dawes** (A'12, F'35). At the 1937 insulation conference, the author presented the results of an investigation of electrical characteristics of ionized gas films, showing variation of voltage, watts, power factor, series and parallel dielectric constant, and other factors under different conditions as a function of current density. Further analysis of these results together with later data has shown that the characteristics determined appear to form a definite part of the cycle through which air between parallel electrodes goes when subjected to increasing voltage. With a uniform gap the voltage gradient for sparking is not constant as might be indicated by theory, but is a function of gap length.

Measurements

The Porous Structure of Paper in Relation to Drying and Impregnation—**D. A. McLean** and **G. T. Kohman.** In the preparation of samples of impregnated paper containing controlled quantities of moisture, it was observed that the moisture content of paper pumped at constant temperature while immersed in a liquid impregnating compound approaches an equilibrium value which differs appreciably from that predicted from the sorption isotherm. A theory based upon the establishment of an equilibrium between surface-tension forces and vapor pressure of water in porous solids has been evolved to explain the effect. According to this theory, the escape of water from a porous solid, such as paper immersed in a liquid impregnating compound such as an oil, can occur at an appreciable rate only if the vapor pressure of the water in the structure exceeds the sum of the capillary forces of the compound and the external pressure. The application of this theory to the following problems have been considered:

1. The study of porous structure.
2. The preparation of impregnated paper samples of controlled moisture content.
3. The determination of moisture in impregnated paper.
4. The drying of paper.
5. The impregnation of paper.

The results lead to the conclusion that a truly dry impregnated paper can be obtained within reasonable time only if the paper is thoroughly dry at the time it is brought into contact with the impregnant.

The Drying of Cellulose Insulation and Electrical Measurements as Measures of Dryness—**Emerson Venable.** Small electrical equipment, such as motors and transformers, made in large numbers, requires accurate control to insure dryness as economically as possible. The following factors related to drying such equipment were studied:

1. Rate of absorption of moisture from the atmosphere.
2. Equilibrium moisture content at various humidities.
3. The drying process as affected by: (a) temperature; (b) relative size of equipment.
4. Use of power factor and resistance measurements as a detector of moisture.

The experiments were performed on distribution transformers up to 25 kva in capacity which now are dried by passing them through a tunnel oven. The equilibrium moisture content and rate of moisture absorption of one type of cellulose-insulated coil were determined. Under ordinary conditions, the rate of moisture absorption is very slow. The actual moisture content of a 25-kva transformer may be as high as one pint of water. Temperature is the major factor in the oven drying of cellulose insulation. Electrical measurements can be used to indicate dryness only when the moisture content is known to be in equilibrium in the whole apparatus. Direct-current resistance readings are not sensitive enough to measure content except where the moisture content is high. Power and dissipation factor measurements are satisfactory under equilibrium conditions.

The High-Frequency Dielectric Properties of Some Filled Rubber Compounds—**S. O. Morgan** and **A. R. Kemp.** This paper reports high-frequency measurements on rubber compounds in which some of the widely used fillers are incorporated into standardized base compounds containing accelerators and antioxidants. The fillers studied include three grades of zinc oxide, two grades of whiting, and one each of lithopone and carbon black. Measurements were made on dried sheets at room temperature. The data obtained confirm the results of previous studies of the effect

Membership—

All Institute members in a position to do so are urged to take an active part in the winter convention, either directly or by absentee discussion. This may be the opportunity to have as your guest an eligible nonmember who would be interested in our activities.

Student members who graduated in 1938 are now eligible to apply for the Associate grade, and will be relieved of the usual entrance fee payment if an application is filed prior to March 1, 1939. All Student members should keep this in mind and tell the others. Application forms will be received from headquarters early in January.

L. L. Webb

Chairman, National Membership Committee

of fillers upon the dielectric properties at low frequencies. Fillers from different sources having different particle size and containing different amounts of impurities, have different effects upon the high-frequency dielectric behavior as well, and the differences are even more pronounced at high frequencies. The data suggest that the dielectric absorption at high frequencies may be due to a polar compound of rubber and sulphur. There is no very strong evidence of a second dielectric absorption arising from interfacial polarizations (Maxwell-Wagner polarization) at the surfaces of the filler particles. It is possible, though not quantitatively verifiable, that the increase in maxima of loss factor with amount of zinc oxide is evidence of such an effect.

Integrating sphere photometers with photoelectric-cell equipment used in the photometric department of Electrical Testing Laboratories, Inc., New York, for determining the output of light sources; an inspection trip to the laboratories during the 1939 AIEE winter convention is planned

Negative Power Factors in Air Capacitors—**A. V. Astin.** Certain guard capacitors when in an atmosphere of high humidity occasionally will show definite negative power factors. The plot of power factor versus relative humidity for any guard ring capacitor shows a pronounced minimum at about 80 per cent relative humidity. Sometimes this minimum extends below the zero axis of power factor giving negative power factors sometimes as large as 7×10^{-5} at 60 cycles. The negative power factors are stable so long as the capacitor is undisturbed, but cleaning and reassembling the electrodes may cause the negative values to disappear. Negative power factors have been observed for guard-ring capacitors with aluminum, brass, stainless steel, and rhodium-plated electrodes. The magnitude with aluminum electrodes generally is about five times that for the others. The negative power factors decrease as frequency of applied voltage is increased. In nearly every case the power factor has become positive at 1,000 cycles. No d-c effects were observed with capacitors showing negative power factor.

An Explanation of Negative Power Factors—**H. L. Curtis** (A'21, F'26) and **A. V. Astin.** Since a positive power factor in a capacitor represents a loss of energy, a negative power factor must indicate that energy is being supplied to the measuring circuit at the capacitor. There seem to be two possible sources of this energy: one, a conversion of heat energy in the dielectric into electrical energy, and the other, a transfer of energy from the guard circuit of the capacitor to the measuring circuit. Since negative power factors have been observed only when there is moist air as the dielectric between the plates of the capacitor, it seems possible that the necessary energy may come from the latent heat of vaporization of the moisture. Computations show that with a power factor of 10^{-5}, and a relative humidity of 70 per cent, 50 days would be required to condense the moisture. Hence, it would seem that the amount of moisture present would furnish sufficient energy to account for the negative power factor providing this energy could be converted directly into electric energy. Thus this type of explanation readily can be made to fit the facts.

Electronic Conduction in Insulating Crystals Under Very High Field Strength—**A. von Hippel** (M'37). A direct measurement of the current-voltage characteristics up to the breakdown point of electrical insulating materials seems to be needed for a better understanding of the stages preparatory to breakdown. Such measurements have been made on single crystals of the alkali halides and mica. A specially designed crystal holder allowed a d-c potential to be applied between two electrodes and the current through the crystal to be measured. The crystal under test could be exposed to longitudinal and transverse illumination. Breakdown appears as an abrupt discontinuity in the voltage-current characteristic, announced only by some unsteady fluctuations in current. Below the breakdown point the current can be drawn over longer time apparently without harm. A possible explanation of this behavior is as follows: Electrons pulled out from the cathode into the crystal by the high field strength applied are transported toward the anode. Part of them come through; others after progressing some distance in field direction become trapped. Correspondingly, a space charge forms, decreasing the field strength at the cathode, and the current decays in time. The negative space charge increases the field strength toward the anode. Electrons liberated from their trapped position by heat vibrations of the lattice therefore will reach the anode. Besides, a second electronic conduction process becomes possible—the pulling-in of electrons from the negative ions into the anode and a backward transfer of this charge defect by electron exchange (hole migration). Both phenomena make a continuous current possible.

New Effects Observed in Glass Due to Electrical Conduction Under the Influence of X Rays—**M. E. Bell.** The glass used in certain X-ray tubes is observed to deteriorate and crack on the inner surface after long service. Experiments indicate that the combined effects of a large thermal gradient through the glass, a high electrical field, and irradiation by X rays are necessary to produce the deterioration. The proposed explanation of the cracks is that: (*a*) the high temperature of the inside glass surface allows electrolytic conduction with consequent change in the composition of that layer of glass resulting in shrinking and cracks; (*b*) the electrical circuit is completed by a kind of body photoelectric effect in the cooler outside layers of glass, and by ionic conductivity in the oil used outside the tube as a cooling medium.

Application of "Schlieren" Photography to Study of the Discharges Preceding Electrical Breakdown in Gas—**S. N. Alexander.** An investigation is being made to study and develop a new method for investigating the predischarge stages of electrical breakdown in gases. The method employed is an adaptation of Toepler's "Schlieren" optical arrangement that reveals the preliminary discharge channels through change in refractive index occasioned by the heat of the discharge. This refractive discontinuity serves as a shutter-like control for a brilliant light source and the channels appear as luminous regions against the dark background. As these temperature rises are entirely transient they must be photographed by a high-intensity short-duration light source that illuminates the optical system at the proper time after the discharge occurs so an optimum of temperature rise and a minimum of diffusion occurs within the channels. A sphere gap is connected in parallel with the electrode arrangement being observed. The spacings are so arranged that failure of the sphere gap will stop the observed discharge at any desired stage through the rapid removal of applied voltage.

HIGH-VOLTAGE STUDIES

The Zonal Power Factor of Impregnated Paper Cables—**F. H. Gooding.** This paper describes a method for determining the changes in power factor which occur across the wall of paper-insulated cables. The sheath is removed from a five-foot length of cable, and the power factor of a 30-inch section in the center of the length is measured. Several layers of paper then are unwrapped, and a second power-factor test is made. From these two measurements the power factor of the zone removed can be calculated. By taking successive power-factor tests as each zone of paper is unwrapped, the power-factor variation through the wall, zone by zone, can be obtained. The purpose of the test is to check uniformity in manufacture and localize deterioration after the cable has been in service. The zonal method has advantages over the method of measuring individual paper tapes unwrapped from the cable, particularly because it gives the power factor and ionization factor of the undisturbed paper wall. Standard laboratory power-factor equipment is used in making these tests. Sufficient data have been obtained to show the possibilities of the zonal method. It should help in studying the effect of paper grading, tight and loose wrapping, and voids in the dielectric, as well as the power factor of the impregnated paper. It provides for the manufacturer a check on his processes and facilitates the study of insulation deterioration for the user.

The Dielectric Strength of Benzene and Heptane—**R. W. Dornte.** Several procedures were used to determine the dielectric strengths of benzene and heptane at 25 degrees centigrade in a uniform electric field produced by a sphere gap. The dielectric strength of heptane also was determined in a nonuniform electric field between concentric cylinders. For heptane, the two types of electric fields give comparable dielectric strengths which are the same with a-c or d-c potentials. Adsorbed oxygen or hydrogen on molybdenum electrodes induces incipient discharges in both liquids. Adsorbed hydrogen or oxygen on nickel electrodes causes no incipient discharges in heptane and slightly increases its breakdown gradient. The dielectric strengths of benzene and heptane are independent of pressure below one atmosphere. The character of the electrode surface, which is influenced by such factors as the degree of polish or etching, the adsorbed gases or ions, and the gases dissolved in the electrode metal, is the most important variable determining the breakdown voltage gradient of these liquids. With the experimental procedures employed, reproducible breakdown gradients can be obtained for both liquids, provided all variables are carefully controlled; but the values of these breakdown gradients vary widely when the experimental procedure is changed.

Luminescence Preceding Breakdown in Insulating Liquids—**H. H. Race** (A'24, M'31). Dielectric-strength measurements on liquids are notorious for the wide spread in experimental results obtained under supposedly similar conditions. A continuously circulating system has been in use in order to examine the factors that may contribute to these variations, such as conditioning of electrode surfaces and removal of water, dissolved gases, and suspended solid particles. During one test a diffuse blue glow accidentally was observed between the one-inch spheres of the test cell at roughly one-fourth the breakdown voltage, which continued with increasing brilliance up to breakdown. Although the breakdown voltage was unchanged, the glow preceding breakdown was completely quenched by admitting a partial pressure of ten centimeters of air to the system. The liquid under test was a 73.5/26.5 mixture of diphenyl oxide and diphenyl purified by vacuum fractionation. The glow was observed when either 60 cycles or d-c potential was applied to the cell. The most probable explanation of this behavior at present seems to be that the glow is fluorescence excited by electrons emitted from the electrodes. As corroborating evidence, this liquid fluoresces under a high-pressure quartz mercury lamp and under high-voltage X rays.

The Dielectric Strength of Impregnated Paper as Related to the Density of the Paper—**J. B. Whitehead** (A'00, F'12). Under certain conditions, impregnated paper seems to present an exception to the general rule that dielectric strength increases with an increase in density of insulating material. It is well known that an increase of compactness of impregnated paper by an increase of winding tension is accompanied by large increases in dielectric strength. Variations in density may be introduced also by varying the specific gravity of either the oil or more readily that of the paper. However, evidence is still wanting as to the influence of a variation in density in either element on those phenomena which are involved in a large increase in dielectric strength caused by their combination. The present research is directed to the question of the influence of a variation in the density of the paper itself on the dielectric strength of an impregnated specimen identical in all other respects. The results so far indicate clearly that there is a decrease of both maximum dielectric strength and of life with increasing specific gravity or density of the paper. The results show also that the inherent properties of the oil-paper combination have a greater influence on dielectric strength than the variations in density considered. These properties are of such a character that an increase in the amount of oil contained in the paper is considerably more important than a change in the density of the paper. Both dielectric strength and life in these tests increase with the value of the ratio of the volume of contained oil to the volume of paper.

Types of Dielectric Failure Which Are Affected by Time—**R. W. Atkinson** (A'09, F'28). Assignment of causes of dielectric failure often has been made loosely and without proper differentiation between causes. The purpose of this discussion was to classify the various types of dielectric failure that are affected by time and especially to distinguish the strictly thermal or "pyroelectric" failure from other types. The "purely thermal or pyroelectric type" is defined as the type of failure in which the sole or chief effect of the electrical stress is the direct liberation of heat. If the heat cannot be carried away as fast as it is generated, cumulative heating occurs, which in time leads to failure. A distinction is made between this type and the so-called "Wagner type of pyroelectric failure." Wagner's analysis is very specific as applying to a special condition of conducting threads of such small lateral dimensions that the thermal conduction from them is lateral to the surrounding dielectric. These threads are smaller in diameter than the thickness of the dielectric. The classification called "ionization leading to pyroelectric failure" is distinguished from the preceding two types only in the fact that while the simple conduction losses in the dielectric are not in themselves sufficient to produce cumulative heating, the additional loss due to ionization is sufficient to bring about cumulative heating; this leads to failure of either of the preceding two types before there has been an important change in the dielectric due directly to the ionization. The "needle point" or "tracking" type of failure is due primarily to the disintegration or destruction of the dielectric by ionization. Failure also may result from chemical change, in which the primary effect of ionization may be to change the chemical composition of the dielectric, resulting in a dielectric of poorer character, and leading in time to failure of one of the other types.

The Effect of Corona Discharge on Cable Insulation—**Joseph Sticher** (A' 30), **D. E. F. Thomas** (A'30), **C. D. Robb,** and **F. M. Hull** (A'33). Studies have been made to investigate what changes if any occur in the electrical characteristics of oil-impregnated paper insulation of high-voltage cables due to corona discharge; changes in chemical and physical characteristics also were investigated. The studies were conducted on small samples of oil and of oil-impregnated paper in specially designed test cells under conditions carefully controlled to stimulate closely the discharges occurring in the highly stressed insulation of a-c equipment in commercial use. The studies on oils were conducted on ten hydrocarbons of known molecular structure and on four oils similar to those offered to the cable trade. The results indicated that a branched chain hydrocarbon was superior to the others in withstanding corona discharge. Both commercial and noncommercial combinations of oils and papers were investigated. Tests with the noncommercial combinations investigated showed that combinations which are inferior with respect to their ability to withstand corona discharge, as judged by power-factor measurements, can be readily detected; tests with commercial combinations as used by manufacturers of present-day high-voltage cables revealed that they compare favorably with the superior ones of the noncommercial combinations. The task of distinguishing between the various commercial combinations on the basis of power-factor increase was found to be very difficult, if not impossible, despite the fact that the samples were subjected to increasingly more severe bombardment conditions in which the length of the bombardment periods, as well as the bombardment voltage, were increased.

Corona Discharge on Rubber-Insulated Cables—**E. B. Paine** (A' 04, M' 12), **H. A. Brown** (A' 16, M' 26), and **W. P. Tyler.** Experiments have been made on some 200 three-foot test pieces of corona-resisting rubber-insulated cable cut from 30 different samples furnished by seven manufacturers. Each was given a test with suitable 60-cycle voltage applied between cable conductor and a flat metal plate on which the test piece rested. The voltage at which corona begins was determined for each piece. The voltage at which corona extends over the entire length of the test piece also was determined.

Furthermore, the relation between applied voltage and magnitude of corona-discharge current was observed. Tests also were made with cable sample and metal plate enclosed in a glass tube with sealed ends, arranged to collect and measure the quantity of ozone produced in a given time. The results have been summarized as follows:

1. The commercial 2-kv cables with ozone-resisting rubber insulation, both with braid and without braid, and its saturant are in general properly rated as to voltage from the corona-starting point of view. Also the 5-kv cables are close to the nominal rating. The 12-kv and 15-kv cables appeared to be overrated since corona discharge occurs below the normal operating voltage.

2. Corona-starting voltages increase with the thickness of the rubber insulation for all samples tested with braid removed and for those without braid. This is not strictly true when the braid is present.

3. For most cables the voltage for fully visible corona along the entire length of the cable resting on the test plate is about 30 per cent higher than the voltage at which corona begins.

4. Ozone is produced in the case of a rubber-insulated cable resting on a metal plate when and only when the potential difference between the conductor and plate is sufficiently great to cause disturbances in the charging current.

5. In some five-kv unbraided cables operating at normal voltage, the presence of corona discharge increases the power factor, when measured on a flat metal plate, to several times the value of power factor at the same voltage but with corona suppressed by the application of air pressure. When the cable has a braid covering, the power factor is markedly higher than the power factor without the braid, and the presence of corona discharge has almost negligible effect on the power factor.

6. The method of detecting the presence of corona discharges by the effect of the disturbances caused by corona on the charging current has been found to be highly sensitive and satisfactory.

Montefiore Awards for 1938 Announced

The jury of awards of the George Montefiore Foundation has announced the following winners of prizes totaling 18,000 Belgian francs in the 1938 triennial awards: Mr. Pauthenier and Madame Moreau-Hanov for work on a high-voltage electrostatic generator, and S. Teszner for his paper on the propagation of electromagnetic waves.

The competition is limited to works presented during the three years that immediately precede the meeting of the jury of awards. Announcement of the availability of the prize appeared in Electrical Engineering for March 1938, page 131. The last award, in 1935, was made to Gabriel Kron (A'30) of the General Electric Company, Schenectady, N. Y.

AIME Elects Officers. Election of officers for 1939 has been formally announced by the American Institute of Mining and Metallurgical Engineers as follows: *President*—D. B. Gillies, vice-president of the Republic Steel Corporation; *Vice-Presidents*—W. B. Heroy and Henry Krumb; *Directors*—L. E. Young and A. B. Jessup, re-elected; Charles Camsell, Department of Mines and Resources, Ottawa; C. A. Fulton, president, Southern Phosphate Corporation, Baltimore; J. T. MacKenzie, metallurgist and chief chemist, American Cast Iron Pipe Company, Birmingham; and F. A. Thomson, president of Montana School of Mines, Butte.

Lehigh University Holds Conference on Engineering

"The Social Significance of Engineering" was the theme of a conference held October 26, 1938, at Lehigh University, Bethlehem, Pa., for the benefit of upper-class students in engineering and others interested. The primary purpose of the conference was to acquaint junior and senior engineering students with some of the broader aspects and responsibilities of the engineering profession and to bring them into direct touch with representative professional and industrial leaders.

At an afternoon session different phases of the theme subject were treated in prepared addresses given by Colonel L. K. Sillcox, first vice-president of American Air Brake Company, Doctor R. W. King, assistant to president, Bell Telephone Laboratories, Inc., and Doctor D. C. Jackson, professor-emeritus of electrical engineering, Massachusetts Institute of Technology. Succeeding the more formal presentations, various members of the Lehigh University faculty, as well as visiting educators and practicing engineers, participated in a general open discussion. Presiding officer of the conference session was Doctor C. C. Williams, president of Lehigh University.

In effect as a second session of the conference, an open meeting of the Engineers' Club of the Lehigh Valley was held in the evening under the chairmanship of L. C. Sprague, president of the club. Feature speaker of the evening was Doctor D. C. Jackson who gave an address under the topic "Engineering's Part in the Development of Civilization."

AIME Honors Member. Sir Henry Cort Harold Carpenter, fellow of the Royal Society and professor of metallurgy at the Royal School of Mines, was presented with a certificate of honorary membership in the American Institute of Mining and Metallurgical Engineers at a luncheon in his honor held recently in London, England. The presentation was attended by some 30 distinguished representatives of the academic and industrial British metallurgical world. The award was made "in recognition of his distinguished achievements in the field of metallurgy as an investigator, teacher, administrator, and organizer and director of research."

Radio Handbook. The 1939 edition of "The Radio Amateur's Handbook" has been published by The American Radio Relay League; in 560 pages this 16th edition presents material on the fundamentals of radio communication, data on the characteristics of approximately 400 types of vacuum tubes, information on the construction of amateur transmitting, receiving, and accessory equipment, and a catalog section. The price is $1 in continental United States and $1.25 elsewhere, paper bound, or $2.50, buchram bound; league headquarters are at West Hartford, Conn.

Future Meetings of Other Societies

American Institute of Mining and Metallurgical Engineers. Annual meeting, February 13–16, 1939, New York, N. Y.

American Physical Society. 226th meeting, February 24–25, 1939, New York, N. Y.

American Society of Civil Engineers. Annual meeting, January 18–20, 1939, New York, N. Y.

American Society of Heating and Ventilating Engineers. 1939 annual meeting, January 23–26, 1939, Pittsburgh, Pa.

American Society of Mechanical Engineers. Spring meeting, February 23–25, 1939, New Orleans, La.

Machine and tool progress exhibition. March 14–18, 1939, Detroit, Mich.

American Society of Testing Materials. Committee week, March 6–10, 1939, Columbus, Ohio.

1939 annual meeting, June 26–30, 1939, Atlantic City, N. J.

Edison Electric Institute. Electrical equipment committee, February 6–7, 1939, Buffalo, N. Y. Transmission and distribution committee, February 9–10, 1939, Rochester, N. Y.

National Electrical Manufacturers Association. Midwinter conference, February 5–10, 1939, New York, N. Y.

Sir Thomas Callender, Cable Pioneer, Dead

Sir Thomas Octavius Callender, founder of Callender's Cable and Construction Company, died December 3, 1938, in Kent, England. He had been associated with the British electrical industry from its very commencement, and, especially in regard to high-voltage distribution, had been one of the pioneers and leaders. Experiments carried out by him and his brothers led to the discovery of the insulating product known as vulcanized bitumen, which was patented in 1881. The following year a company was formed to manufacture insulated wires and cables, and during the next few years a large proportion of the early underground mains in London and the provinces were manufactured and laid by the company.

One of Great Britain's outstanding industrialists, Sir Thomas Callender was born in Glasgow, Scotland, in 1855, and after completing his education in England and France entered his father's asphalt paving and bitumen-refining firm, Callender and Sons. In 1896 he became managing director of the newly formed Callender Cable and Construction Company. He was knighted in 1918, and was a director in many enterprises, including several power companies of Great Britain.

Current Items From American Engineering Council

Invention Discussed at Second Forum

Some 200 industrialists, heads of research departments, patent lawyers, and engineers engaged in a spirited discussion of "Invention and the Engineers' Relation to It" at the second forum of American Engineering Council, held in Detroit, Mich., November 11, 1938. The forum, in subject and in time, was scheduled so that the viewpoint of the engineering and allied professions might be expressed with regard to invention as a contribution to the hearings held in Washington during December, under the direction of the so-called Temporary National Economic Committee, sometimes called in brief the "Monopoly Committee." It may be recalled that Senator O'Mahoney the chairman of this committee, made a vigorous plea for the Federal incorporation of business enterprise, at the annual meeting of AEC in Washington in January 1938.

The purpose of this forum, as in the case of the first forum which was held in Philadelphia, and of the others which are to follow, is to provide first, a series of basic papers on the several factors involving the subject and, second, discussion both by members of the engineering profession and of the allied professions and representatives of the public in such a way that the combination may be considered a contribution to the public good.

The presentation of the papers and the discussion which resulted indicated that there were three groups of interest in this field of "Invention and the Engineers' Relation to It," namely, the public, the inventor, and the business which makes use of the invention. The public interest is evident in the fact that invention creates new products, new processes, new methods, and thereby creates social and economic questions paralleling the development of industry. In the second place, it was made clear that invention can only be fostered by stimulating and rewarding the inventor, since an invention is an "intellectual property," and in various countries, various systems of protecting and rewarding the inventor have been developed. This led to a discussion of the American patent system and its advantages and disadvantages as a method of protecting "intellectual property." In the third place, the papers and the discussion developed the thought that invention today is one of the end products of scientific and technological research, that a long period of time may often elapse between the germ of an idea and the culmination of the fruits of the invention in terms of a manufactured product. The several phases of this were explored by representatives of both research agencies and industry.

The first formal discussion was presented by K. H. Condit, assistant to the president of the National Industrial Conference Board. Mr. Condit took as his subject "Social and Industrial Values of Research and Patents" and pointed out the part played by invention in the social and economic advances of the United States, with specific illustrations in the fields of heating, farming, implements of war, milling, and textiles. His paper tended to show that social and economic advancement in the United States preceded or paralleled what Mr. Condit called "social invention."

Doctor Lyman J. Briggs, director of the National Bureau of Standards, took as his definition of research, the classification as presented by Julian Huxley in his book, "Science and Social Needs." He divided research into four categories: (1) background research with no practical objective consciously in view such as atomic physics; (2) basic research which must be fundamental in character but has some distant practical objective, such as the study of fluorescence with the distant possibility of producing cold light; (3) *ad-hoc* research, with an immediate objective, like research on discharge tubes for lighting purposes; and (4) development of engineering research which is the work needed to translate laboratory findings into full-scale commercial practice. Doctor Briggs discussed the place of government in research and concluded with the broad statement that there was a great opportunity for the government to develop basic research which lies between so-called background research and *ad-hoc* research. He expressed the belief that the ultimate objective of such basic research by the government is to provide the foundation for new industries.

T. A. Boyd of the research division of the General Motors Corporation then discussed the subject of research in its relation to industry and invention, drawing on the experience not only of the automotive and allied industries of petroleum and aeronautics but of photography and medicine. His address was full of specific as well as entertaining illustrations of how research has been put to work in improving existing products, in making entirely new products, in reducing the costs and consequently lowering prices, of finding uses of by-products, and in supplementing failing resources. He emphasized the place of research as a creator of jobs and quoted C. F. Kettering as follows: "As a people we have got to decide whether we are going to go on building America, or whether we are merely going to operate it. In the past the twin jobs of building and operating the national producing plant and the transportation and distributing systems have utilized most of our men and resources. Now are we going to drop back to the mere operation of the plant, or are we going to visualize new and greater industries ahead and begin to plan and build for them?"

Harry H. Semmes, chairman of the patent survey committee of the American Bar Association, presented the proposals of that association to survey the American patent system with special reference to bringing information before the Temporary National Economic Committee. He asked a series of questions in his paper including the following: "Are patents purchased and pigeon-holed and are they used improperly to create monopolies?" "Is it sound practice to bring suits in other jurisdictions to obtain conflicting decisions on patents?" "How can this condition be remedied?" "How can we improve procedure so that the hardships and costs of litigation both for the plaintiff and the defendant may be reduced?" Mr. Semmes said: "As everybody knows, patent litigation is a luxury. There should be some way of cutting down the costs and the delays incident to these infringement controversies. I believe there are very few patent lawyers that would not welcome some way of cutting down the expense of litigation and the delays in getting final decisions." He concluded:

> America has progressed by taking a chance. The patent system tends to minimize the risks incident to the early stages of the founding of an industry. When you look about you, you will find that the patent grant furnished the power that launched the cotton gin, the radio, the automobile, and so on.
>
> A patent system functioning properly, and properly encouraged, will bring venture money out of its hole where it has been hibernating the last few years. The venture money of today may start the industry employing many tomorrow. Possibly something should be done to encourage investment during the early stages of enterprises based on patents. No specific recommendation is made, but something might be done along the lines of remission of taxes for the first few years of a venture built on patents, or some other stimulus might be used to help the patent system expand the one remaining frontier; the frontier of human wants.

The paper written by Doctor F. B. Jewett (A'03, F'12) vice-president of the American Telephone and Telegraph Company, was presented by his associate, R. W. King (M'35) because of Doctor Jewett's absence on account of illness. Doctor Jewett stressed the fact that much of the agitation for changes in the American patent system arises from ignorance over the origins and purposes of granting patents. Patents once were royal special-privilege monopolies bestowed by monarchs, said Doctor Jewett, and they could be granted for most anything: the trade in salt, tobacco, spices, and so on, as well as for exploitation of colonies. As a form of what would now be known as political patronage, abuses arose under this system until, in England, Parliament wiped all patents from the books for all time except for patents in the domain of new and useful things. He pointed out that it is easy to lose sight of the cardinal principle which is the secret of the patent's power. This is the concept that a patent is—for a time—private property just as land, a home, or personal possessions are private property. As private property, patents can be used freely and they possess the right to exclude others as one could exclude trespassers from land or home.

"Tamper with them (these concepts) and we tend to destroy the power of the system to do in the public interest that which it was created to do," Doctor Jewett continued, "namely, stimulate new, useful inventions and afford a means through protection of the state of making them widely known and available to the public. Invention alone cannot do this—it must be combined with capital and immense labor of many men. Denied promise of protection capital will not venture and men will not labor voluntarily."

The AEC chairman, Doctor William McClellan (A'04, F'12) closed the conference by summarizing briefly the high spots of the meeting, and outlined his belief that the type of discussion that had been held was truly professional in character, and that it was especially notable that there had been present during the discussion, not only representative engineers and industrialists but members of the professions of law, of economics, and of teaching.

Letters to the Editor

CONTRIBUTIONS to these columns are invited from Institute members and subscribers. They should be concise and may deal with technical papers, articles published in previous issues, or other subjects of some general interest and professional importance. ELECTRICAL ENGINEERING will endeavor to publish as many letters as possible, but of necessity reserves the right to publish them in whole or in part, or reject them entirely.

ALL letters submitted for consideration should be the original typewritten copy, double spaced. Any illustrations submitted should be in duplicate, one copy to be an inked drawing but without lettering, and other to be lettered. Captions should be furnished for all illustrations.

STATEMENTS in these letters are expressly understood to be made by the writers; publication here in no wise constitutes endorsement or recognition by the American Institute of Electrical Engineers.

Treasurer Slichter Writes From Rio de Janeiro

To the Editor:

I have your air-mail request for a short account of my experience during my travels in South America and am glad to comply.

The most beautiful asset of Rio is the natural setting of its harbor which is best seen at sunrise, at which time we entered, and every one was repaid for sacrificing his sleep.

The city itself has some handsome buildings and avenues, but the only thing which aroused my enthusiasm was the series of fine avenues, quays, or "praias" as they call them here, stretching along the beach for miles, around one curving bay after another. The Brazilians have realized this asset by developing it splendidly and giving it fine electric illumination at night.

I found the electrical development of the city quite progressive. The local power company is privately owned (Canadian) and is up to date: a-c network, transformers in subterranean waterproof vaults, network protectors, and substations with all the modern controlling and protective devices we have in the States. There is much underground distribution in the city. Most of the power is hydroelectric, only a ten-per cent reserve in steam. Rates are low from our point of view. A frequency of 50 cycles is used here and 60 cycles in the nearby city of São Paulo—a problem for the future. On November 14 the president issued a decree that hereafter 50 cycles is to be the standard in Brazil and that in ten years all 60-cycle systems must be changed over.

The telephone service is also excellent (same company); 85 per cent of subscribers are on automatic and a foreigner can get his station as easily as in New York, but if you get a native servant when you call then there is trouble.

Most of the trouble here is "nationalism." As a result the international exchange is very bad against those having investments here, but very good for travelers like myself. The government uses much of the exchange credit for governmental purposes, including munitions, and the business man in the States must wait to be paid.

Germany outsmarts us by taking specifically ear-marked products of Brazil in exchange for machinery and munitions. Germany is glad to get cotton, coffee, and cocoa.

Nationalism shows itself in a recent law on "licensing of engineers." As a consequence no foreign engineers may practice here in the future (those residing here about ten years before the law being excepted). There is a dearth of good engineers here, particularly of young ones, and I do not see what the country and the operating engineers are going to do. From what I see there are very few technical schools with adequate laboratory facilities to train good engineers. Their instruction in theory in many cases is very good but their laboratories do not compare with ours and render it difficult to give practical engineering experience which we give in the U. S. A.

Nationalism and the control of foreigners is shown by my experience. I arrived at the port of Rio and satisfied the state, police, and immigration departments; promised I would not seek employment and that I would leave in a definite time; and proved that I had means of support while here. Now, I want to leave by the port of Santor, instead of Rio, and I have been to the United States consulate and have to go to the police tomorrow to get permission.

We came down on one of the reconditioned, electrically propelled, ships of the United States Maritime Commission, and I cannot say enough in praise of them.

Sincerely yours,

W. I. SLICHTER (A'00, F'12,
National Treasurer)

(Professor of electrical engineering and head of department, Columbia University, New York, N. Y.)

The Paradox of Social Progress

To the Editor:

In ELECTRICAL ENGINEERING for November 1938, L. W. W. Morrow and Doctor Robert E. Doherty have opened up the matter of college training for further discussion.

Perhaps what we study is less important than why we study and how we study. If we cannot give a concise answer to why, criteria are lacking for the determination of what we should study. Such reasons as—we study to prepare for life, or to secure background, do not satisfy. The student must decide what kind of life he wishes to lead before he or anyone can pick studies which will either prepare him to live it or furnish him with a background against which to live.

As children we are told to learn this and that, which the elders in their wisdom have decreed. We learn because we are told and in some cases the discipline of learning to do what we are told is all we get out of it. At some stage in development those who are to make decisions determining future conduct must begin to make them. Each must decide what he wishes to accomplish. Then he must decide what steps he thinks will help him toward his goal. To this end many will advise him, but many or all of the advisers may be wrong and he pays for their mistakes. Therefore, the student must test each step as he takes it to see if it is taking him nearer to his goal; to see whether it is taking him nearer his goal at a rate commensurate with the effort expended.

If a student is preparing himself for a job he has to pick the job he wants and then inquire of his prospective employer what preparation that employer wants. Be realistic about it. If you want to sell Fuller brushes you must understand the housewife; if you want to sell insurance you must understand the average American mind. Latin and Greek, French and German, mathematics and physics, history and geography are of very little value. You may not wish to appear an ignoramus, but very superficial knowledge will preserve the appearance of education.

If you want to design bridges, mathematics and physics are right up your alley. You can find out exactly what to do and do it as directly and single-mindedly as possible.

If you don't know what you want, the problem is not simplified by all the people who are ready to tell you. The world is all cluttered up with college graduates who have spent from four to six years fitting themselves for occupations which they find entirely uncongenial, or for which they are not adapted by nature.

A boy who does not know what he wants had better make a choice while he is young. Tests are available which will tell him in what direction his aptitudes lie. Other tests will tell him what occupations are consistent with his interests. But above all let him choose and make an early trial of his choice. If the choice is wrong he can try again while he is young. After he graduates with an academic training only, he will probably want to get married. He may take the first job that offers and be stuck, a misfit for life.

A great deal has been said and written about overspecialization. The danger is of two kinds. A man who knows only buggy whip design is very vulnerable to technological change. A man who has made a million from patent medicine may not know what to do with the money when he gets it. The first of these dangers is the more serious. The student must acquire as much collateral information as he can in the direction he wishes to go as soon as he finds what that direction is. Then he will be prepared to adapt himself to changing technological developments. The successful man may acquire culture. The cultured gentleman with no specific training has a hard road in achieving success.

There is of course a happy mean, but here again clear thinking is necessary. The goal must first be selected; then the steps toward the goal; then the test of the steps to see if they are the right steps; and if the goal is the right goal. Internal resources of satisfaction help a man to give his best in any struggle. Music and literature or hobbies may provide those inner resources. Whether anyone of them really does provide such resources or not is a question of fact and not dictum. If a man does not like music and does not like literature, it is very unlikely that pursuit of them will do him any good, although he owes it to himself to give them a good trial to be sure. If he does like literature or music, he must pursue them with discretion. They may be icing for the cake, but he must get the cake.

There is one more reason for the procedure outlined herein; the three steps of selecting the goal, choosing steps toward the goal, and testing steps and goal. If a man prepares himself for a job thoroughly, he may make himself a good follower. He may be ever so competent at doing what he is told and still, as many have found to their sorrow, he may not find a job, may not find a leader to follow. Some one must learn to be a leader. A leader must select goals for himself and others. He must select steps to be taken by himself and others and he must check test with correspondingly greater care.

If a man is content to be a follower, he can ask what is wanted of a follower and do that. If he wishes to be a leader, he must select his star himself, and test the steps toward it. The sooner he begins the better. The function of the institutions of higher education is to teach the followers it is true, but it is even more important that they give potential leaders an opportunity to learn the techniques required of a leader.

Very truly yours,
D. C. Prince (A'16, F'26)

(Chief Engineer, General Electric Company, Philadelphia, Pa.)

To the Editor:

> When you can measure what you are speaking about and express it in numbers, you know something about it, and when you can not measure it, when you can not express it in numbers, your knowledge is of a meager and unsatisfactory kind—Lord Kelvin.

Although the manifestation of interest by scientists and engineers in the influence of their achievements on "social progress" is no new phenomenon, nevertheless, it is gratifying to read in a technical journal such masterly discussions as those of F. B. Jewett and R. E. Doherty. Every contribution of that nature adds greatly to the enlightenment of citizens and to our understanding of a mysterious subject.

In the light of the above sincere expression of appreciation of the contributions of Doctors Jewett and Doherty, it may appear inconsistent to analyze some of the statements made; to point out some of the unscientific and unwarranted assumptions, and some of the *non sequitur* conclusions in Doctor Doherty's paper. The following comments, however, are intended to be supplementary to and not merely critical of what he has said so well.

If I read Doctor Doherty's paper aright, he bases his argument on the assumption that scientific discoveries and technological developments have so increased the "complexity of social organizations" as to threaten the disorganization of social order. To gainsay this major premise is difficult and perhaps impossible because of the generality and indefiniteness of the terms "social organizations." Unless these are more clearly defined and the influence of technological developments upon these organizations are more cogently pointed out, the conclusions based on the premise may and may not be true.

It appears, however, that the difficulty or crisis he visions is not so much due to the complexity of social organizations as it is to the continuing and accelerating specialization and division of labor. The assumed cause of present-day economic crises is more commonly expressed by the saying "that the complexities of modern life have so increased as to threaten the stability of society." A state supreme court used that assumption as a major premise in one of its important decisions by which it justified the encroachment of the state on private enterprise. The facts, however, seem to point in the opposite direction. The lives of most men are not greatly affected by the complexities of social organizations, but by the simplicities of their occupations and activities. In short, therefore, it appears that attention is being centered upon the wrong factors. For example, the life of General Isaac Wistar in comparison with the lives of present day factory workers was complexity itself. He was hunter, trapper, muleteer, voyager, gold miner, gambler, Indian fighter, financier, administrator, doctor, speculator, lawyer, farmer, army general, philanthropist, etc., etc. There was no division of labor in so far as he personally was concerned. He, and he alone, had to perform all of the activities and duties necessary for the maintenance of life.

In contrast, the present-day worker learns one trade or operation and is forbidden by his union to do anything else. He gives little or no need to the complexities of the organization that provides him with the means of earning a livelihood. Wistar was independent, but the present-day worker is dependent upon others for his well being and the cause of many, if not most, of present day labor controversies, is his and his leaders' failure to recognize this interdependence. If one section of his union closes the stock yards, another section in the packing plants has nothing to do. When one occupation failed to yield a living, Wistar turned to another.

In commenting on a certain professor's notion of a new educational technique, Walter Lippman most vividly emphasizes this dependence and its consequences. He says:

> Consider what this principle of education means. It means a population which not only uses machines as a convenience, but has been so entirely dependent upon them that the ordinary man would not know how to find out whether the automatic calculator was accurate or whether it was honest. He could not even go to an expert and ask him to test the machine. For if two experts disagreed, he would not know enough of the elements of arithmetic to have any ground for deciding which expert he ought to believe. . . . Now, it is, I believe, this ever widening separation from the elementary facts, the elementary truths, and the elementary necessities of human existence that the profound confusion of modern men originates.

Perhaps the "complexity of the social organizations" is the cause of the interdependence of all of us, but no effective reform in social organizations and educational systems is possible unless the specific influence of each upon social progress is understood.

The affirmation that "technological progress, even at the present rate is leading us into economic confusion, etc." is an assumption as old as technology and as invalid today as when it first entered men's minds. This notion is a deduction from the sequential relation of technological development and economic depressions, and it has just about as much validity as Chanticleer's assumption that his crowing caused the rising of the sun. If the present economic and industrial depression were the first in human history, the *post hoc ergo propter hoc* type of reasoning would appear valid, but in the United States alone, from the starting time of the Jamestown colonists to the present, there have been several periods of economic distress. None of these preceding crises could be charged to technological progress.

Most assuredly the distressing panic of 1837 must have had some other cause. Manual labor was then the only means for providing economic security, and yet a journal of that time, *Common Sense*, said: "Misery and starvation stare us in the face." But there is more cogent evidence that technology is not the cause of prolonged unemployment.

The annual report of the first commissioner of labor, Carrol D. Wright, has often been cited in confirmation of the charge that technological development produces unemployment, but seldom if ever, does anyone take the trouble to read what he said in his book "Industrial Evolution of the United States" written six years later. In that book he shows that during the 30-year period from 1860 to 1890 the population of the country increased by 99.16 per cent and the number of persons employed increased 176 per cent. He concludes his analysis of the relation of technology to unemployment by saying:

> If statistics could be as forcibly applied to show the new occupations brought into existence by invention, it is believed that the result would be still more emphatic.

But let's get back to Lord Kelvin's axiom and show its relation to some of the criticisms of the imperviousness of engineering students to nontechnical theories and ideas. The axiom explains Professor Elliot Smith's difficulties in his efforts to persuade engineering students to accept mere opinions as conclusive and infallible. Opinions whose premises cannot be measured and expressed in numbers disclose a meager and unsatisfactory knowledge. The solutions to social problems proposed by economists and sociologists are always based on hypothetical premises and assumptions that neglect, or ignore, many important but variable factors. Some of these factors are the unpredictable, unmeasurable, and uncalculable wants and tastes of peoples. The junior and senior engineers in Professor Smith's class were not at fault. The fault lay in the assumption that what Doctor Alexis Carrell calls "conjectural sciences" are true sciences.

Likewise the axiom of Lord Kelvin is apropos the affirmation of Doctor Doherty that "we should bring up a new professional generation . . . who understand social relations and organizations, who comprehend the effects of their works upon society, and who have arrived at a philosophy that is in harmony with the ideals of democracy."

When and how has the influence of the works of the scientist and engineer been measured, and in what units has it been expressed? I know of none. That the effects are profound no one questions, but the mere expression of this evident fact is no evidence of a profound understanding of these influences. How can generations be trained to understand that which the trainers themselves do not understand? Who is there with sufficient wisdom to formulate into cogent and readily comprehensible form the principles and mysteries of social progress? The philosophy of Aristotle dominated the minds of peoples for nearly 1,500 years, but is there anyone today with enough hardihood to assert that Aristotle understood social relations and organizations? And if so, why have the social relations and organizations that he understood been changed by technology more in the last 200 years than by all the philosophies written since his time? The simple experiment of Galileo with falling bodies has changed both the thinking processes and social organizations more than any comprehensive social philosophy.

Again, human beings never have been, and are not now omniscient, which they would have to be if they understood, *ab initio*, the effects of their works on the social order. How could Faraday have visioned the use of his discovery by a government to stifle private initiative in the twentieth century? A vision he probably did have, but it was wholly inadequate for the formulation of a social philosophy. Most assuredly the workers in electronics never even dreamed that their discoveries would be used to scare thousands of people out of their wits by a realistic broadcast. Clerk Maxwell was merely solving some mathematical equations. He could not forsee that the solution of the equations would stimulate the thinking process of men to the development of devices that would within a short time save some 700 lives on the steamer *Titanic*. And finally, what are the ideals of democracy? Let's not forget that human beings are as varied as "the autumnal leaves that strow the Vallombrosa." No one knows what is the greatest good to the greatest number, and engineers are no exception to the rule. Social progress is not a paradox but a mystery.

These supplementary comments should probably end here, but a few words may properly be said about the proposition that a more philosophical and special training of the engineers will "resolve the country's serious dilemma." The ineffectiveness of a specialized training of other than engineering students for the promotion of social progress is recognized by Doctor Doherty, and yet he assumes that some form of specialized training for engineers will be effective. Let's not delude ourselves. There are enough delusions extant now. All forms of specialized training have been ineffective primarily because what we so glibly call social progress is in reality a mystery. Some one has said that the cause of war is the persistent push of protoplasm. The same persistent push produces all social movements, but what causes the persistent push of protoplasm, and how can it be directed into what we consider proper channels? A clearer "understanding of the parallel growth of sciences and engineering, on the one hand, and social customs, relations, and institutions on the other, and how these have reacted on each other" would make everyone who acquired such an understanding a more intelligent being, but to think that such a training given exclusively to engineers will "resolve the country's serious dilemma" is a vain hope; and that mainly because there is greater need of a more general and different kind of education.

After recounting the many political, social, economic, and industrial changes that had taken place during his varied and fruitful life, General Wistar wrote:

> It is doubtful whether a corresponding advance has been gained in political knowledge, and it now seems as though the life of nations—or rather of governments—is tending to even greater instability, notwithstanding the general opinion of the eighteenth century publicists that political stability was dependent on popular content, and popular content on popular comfort.

When Athens became a democracy, the avenue to power was not scientific attainments supplemented by a philosophical understanding of societies, but fluent speech. Democracies have changed but little since then, and the type of education needed is one that will make the electorate skeptical of the fluent speakers.

Very truly yours,
C. M. JANSKY (A'06, F'32)

(Professor of Electrical Engineering, University of Wisconsin, Madison)

To the Editor:

I am grateful to Doctor Doherty for his article, "The Paradox of Social Progress," in the November 1938 issue; I wish to comment, if I may, with the following:

A few years ago when "Technocracy" came, I warmed about the neck and produced a little book about the matter (now out of print). In the book I gave expression to the belief that society is suffering, not from too much invention, but from too little. I still feel very strongly that very considerable invention is the crying need—sociological invention.

I rather feel that the patent laws have established the urge of money reward very substantially, for physical invention and development. My earnest belief is that technological progress may be depended upon to obey Newton's first law, and continue in motion. I believe that our anxiety for future technological progress should have its energy diverted to a concern about the development of that form of culture which has to do with the undeveloped matter of assimilating each other. Our anxiety should now very much concern the behavior of the human race.

There are no patent laws to reward inventors in the field of sociology; no one is in the market for the discoveries of the technician in the laboratory of economics. Men are still behaving rather primitively under the stimulus of money. No inventor, in the alleged science of political government, for instance, seems to have obtained a reward for his achievement, approaching that which must have come to King C. Gillette, or to the gentleman over in Baltimore, who invented the collar-band for shirts.

It is not a matter of lacking talent. Human creativeness can solve any problem that confronts it. But a certain adage needs reformation: Necessity is not the mother of invention; both the parents of creativeness have the same name—*reward*. I regret as much as anyone that this seems true but if it is true perhaps it is a blessing to know it. I believe that stupid idealism often avoids the truth about ourselves.

The germs, chromosomes, and genes that have produced our great technicians, engineers, and scientific men and women, were fathered by great grandads who never, in their day suspected the age we now live in. Talent came as needed. *Reward brought it out.* I believe there is plenty of latent social talent also.

The average student-engineer knows so little about people that it is pathetic. Occasionally he has some statistical knowledge of them; so much traffic over telephone lines; so many units to be transported somewhere. He does not seem to know that all the things he is trying to learn would be entirely useless in a world without people. Someone, in some engineering school somewhere, should tell him, sometime, that the beautiful Chrysler Building would be useless on Pitcairn Island—and why?

Engineering students become engineers; some of them. Not knowing people, they do not know their responsibilities to people. If there is any beginning to sociology, it is when we glimpse the first faint ray of responsibility to each other. Many engineers are notoriously stupid in even the most elementary notion of social responsibility. They deluge the country with gadgets all in the name of an improved "standard of living." Their neighbors borrow two billion dollars annually from "small-loan companies" at from 12 to 36 per cent per annum, to buy this improved standard of living. Money spent for interest cannot buy other things. Diabetes, an anxiety disease, increases; 20 per cent of us become mental patients at some time or other. Worry becomes the nation's prime affliction.

There is some pain-in-the-neck controversy about technological unemployment. We have our ideas about that. But does the engineering student have anyone to tell him that idle man-days are customer-days lost forever? Does he know that when he invents a strip-mill that replaces a string of sheet-mills, that a lot of customers-days are ruined for good? Does he realize that, regardless of what his creations will do, the greatest engineering necessity is the *conservation of customers?*

Is the engineer conscious of the part he has had in raising the employment intelligence level? I have talked with a lot of them who do not seem to grasp significance in the fact that the intelligence required to drive a team of mules, may not be nearly high enough to drive a tractor. What is the engineer's responsibility to mule-drivers; has the engineer exercised his creative ingenuity in devising some way to conserve the mule-driver as a customer? If not, why not?

Does the engineer know his responsibility toward war; for war? Does he realize that the entire horror of it rests upon his doings? What social justification, for instance, can he give for his development of TNT? Does he ever contemplate that if he should collectively refuse, no war could be fought? I sometimes wonder if a selected thousand engineers could not stop the whole bloody business; maybe the sulphuric acid industry could do it. Does the engineer see in war the awful use of machines of his own creation, and does he feel the responsibility for what these machines can do to people—customers? What does he know about people anyway—the lunatics who want wars; the lunatics into whose sadist hands he entrusts his creative ingenuity?

So what? Well why not let the young fellows in on a new subject, tremendously more interesting than sociology? Every last one of them could be sold on a course in human behavior. The boys and girls go to "tech" with a geometric idea that a straight course is the shortest distance to what they think they want in engineering. These boys and girls want what they want. They may be compelled to eat the dry grass of sociology, but there will be few to digest it. They feel they can read about it later in a mahogany office while waiting for big-fee patrons; just now it's engineering they want.

A lot can be packed into a course listed as human behavior; the student may even be introduced to a mentality of his very own that he never suspected; the mentality of the *crowd*. He can be shown what people do, how they do it, where, why, and when. Into such a course all the dry bones of sociology can be tucked that are worth tucking.

If ever the dear old world needed inspiration, to begin an understanding of itself, it is now. Are we not over-educated along certain lines? Education is a mental tool; many of us have accumulated a storehouse full of tools we have not learned how to use. We have been teaching at history for example, for centuries; it has been one of the very favored scholastic indoor sports; it is good for but one thing: to judge the future by the past. Sociology is somewhat like history, a sort of statistical record. I feel pretty strongly that we have been listening long enough to the clock of time, now let us go to work on an understanding of what makes the clock tick.

Isn't it about time we are learning a little about people ourselves—we who presume to teach? The best teacher I ever had certainly was not an intellectual giant but, shades of Socrates! he knew how to make his samples talk me into a carload of the product, anytime he wished.

Sell the boys and girls a course on human behavior; maybe a less erudite name would go over better. Perhaps "How to Understand People" might click. If you don't believe there is interest in this sort of think ask Dale Carnegie.

If you can get them interested in people you will have done a lot; perhaps in later years when they have grown fat with affluence and prestige, they will see to it that some pressure is put on the schools to teach the beginnings of human understanding where the beginnings should be taught. Perhaps they may be willing to have children taught courage and thereby clear their minds of half the world's anxieties. Perhaps instead of so much penmanship we can give them all typewriters and then use the time to inculcate that fundamental of all culture—self-restraint.

But in heaven's name, don't hand the green students sociology. I never met an engineer who knew anything about sociology two years after he was out of college. The student wants something he can use. He asks of himself, subconsciously perhaps, "What will it do for me; when; why; how?" We must be able to tell him in words even babes can understand. By this route, Doctor Doherty, I venture, you can lead your engineers into an appreciation of the world of people and an understanding of what folks really want long before they themselves know what they want. Knowing what the human want-forces are, their magnitudes and their directions, perhaps we may be in better position to align, orientate, and co-ordinate much that now seems chaotic.

Cordially yours,
JOHN G. HOMAN (M'18)

(Private Research, Atlantic City, N. J.)

To the Editor:

For his article Doctor Doherty merits abiding thanks. Today as they look about, engineers find no small confusion. Socially conscious persons, engineering leadership, and laymen are insisting science show "purposeful" activity and specify its stand of "for" and "against." Meantime techniques, as applied, are focussing the good and bad of the human system for impersonal view by the vulgar and undiscriminating.

The now somewhat suspect "old" engineering curriculum certainly stressed sequential causation. Thereby it made poor preparation for the practical world of business, of force, of magic, of make-believe. "Strategy, show of force, froth of words and cunning" have the appeal of reality (as in snob advertising) to the "clumsy milling mass of a now confused democracy." The "stupid people who have a hand in affairs" are no adventitious feature of our culture. They are the sort who carry conviction to the mass. Addiction to causal sequence is not only poor training for significant accomplishment in the socio-economic field; it is an excellent means whereby one can earn a reputation as a very sinister fellow.

Nevertheless, reliance on the principles of this suspected method produced a type which was not at a loss upon contemplating the world of men. They could and did view it, could and did specify it—as in this article, could and did take part in it without too much emotional disturbance to self. Therefore it is sincerely to be hoped that anthropology will find a place reserved for it in any "new" curriculum.

If engineers actually determine to do humanity a good turn by acting in the manner of design technicians they will need truth as against romance. This is what has heretofore made their method of consequence. Therefore it is most encouraging that leadership is capable of such statement as this article. It requires courage as well as insight to state the paradox with which the author introduces his thesis. The several years obscurity to which it was consigned is a measure of its unpopularity and of the reward parcelled out to the original exhibitors. The truths on which action possibly may be based are such that they can safely be expressed only by men of evident attainment and unquestionable orthodoxy. Persons of less stature could but expect the charge of disingenuousness.

Very truly yours,
J. ANDREW DOUGLAS (A'18, M'29)

(Physics and General Science Teacher, Mobile, Ala.)

Critical Conditions in Ferroresonance

To the Editor:

Mr. Thomson, in closing the discussion of his paper ("Resonant Non-Linear Control Circuits," AIEE TRANSACTIONS, August, 1938, pages 469–76) calls attention to a "serious approximation" made in "Critical Conditions in Ferroresonance" by P. H. Odessey and E. Weber, AIEE TRANSACTIONS, August 1938, pages 444–52.

The point in question concerns the term under the radical of equation 4,

$$E_L = \pm\sqrt{E^2 - (IR)^2} + \frac{I}{WC} \qquad (1)$$

which is said to represent an ellipse whose principal axes have values E and E/R, respectively. Mr. Thomson contends that this term is an ellipse only when the resistance is constant, and that since the apparent resistance of the reactor, which must be considered part of the total series resistance, varies with current, the representation as an ellipse is a serious approximation.

Mr. Thomson's contention that equation 1 is an ellipse only for constant resistance is quite correct, but the fact that it may not be an ellipse if apparent resistance is included is not important since the curve it represents in general is a closed one that intersects and has tangents with the reactor characteristic. Thus, no serious approximation has been made in the fundamental equation since apparent resistance may be conveniently included in the final analysis.

In the original paper, equation 1 formed the basis of a general interpretation of ferroresonant phenomena and for simplicity of discussion, resistance was assumed constant. In consideration of specific problems, however, the importance of apparent resistance was carefully noted and taken into account. This has been amply demonstrated in several examples.

Respectfully yours,
PAUL H. ODESSEY (A'38)

(Development Engineer, Heyer Products Company, Inc., Belleville, N. J.)

A Self-Checking System of Supervisory Control

[* Editor's Note: The following two discussions were received too late for inclusion in the 1938 volume of AIEE TRANSACTIONS, and because of extenuating circumstances are presented here.]

To the Editor:

In reviewing the paper by M. E. Reagan (AIEE TRANSACTIONS, volume 57, 1938, pages 600–05), I was interested to determine if there were advantages gained other than that claimed by the author as the primary purpose of the development, namely "to reduce the selection time."

Perhaps the most welcome advantage, which would be acceptable to both the manufacturer and the maintenance man, would be a reduction in the amount of equipment required in a system of this kind. Since it is necessary to select circuits at both the dispatcher's office and the substation and because modern supervisory designs utilize the same common equipment for selection and check-back purposes, it would appear that there is no major reduction in device equipment and little, if any, gain in circuit simplicity.

The illustration given involves a ten-impulse code for 100 selections. Four of these impulses are three times the length of the short impulses. The selection code therefore requires 1.8 seconds for its transmission.

In contrast to this, the General Electric Company's code selector supervisory system requires a seven-impulse code of two characters for 100 selections. On the same basis of transmission speed the selection and check-back codes are both transmitted in 1.4 seconds. This leaves a fair average interval of 0.4 second for the automatic setup of the check-back code if we put the two methods on a comparable basis. The difference in selection time between these two methods therefore appears to be of rather insignificant magnitude.

The development of the art of remote supervision of electrical power apparatus has been based upon the policy of "accuracy first." There has been no compromise on this point. I believe this factor accounts largely for the excellent performance record of the modern installed systems. Some of the more or less infrequent and somewhat intangible sources of trouble have been considered in these designs.

The author in conclusion mentions some of the possibilities of wrong selection due to code interference. If we accept these possibilities of deletion, shortening and lengthening of impulses for which protection is provided, is it not also conceivable that adjacent long and short impulses may be respectively shortened and lengthened so that they are interchanged in the code and cause a wrong selection?

Relative to the matter of selection speed, it would be most interesting and instructive to have comments from operating organizations who have modern two-wire code systems in service. In what percentage of operating cases does the power dispatcher have to noticeably wait on the supervisory system?

Very truly yours,
C. E. Stewart

(Engineering Section, Panel and Equipment Division, General Electric Company, Philadelphia, Pa.)

To the Editor:

Mr. Stewart concludes that the system sacrifices accuracy of selection for speed, a greater number of relays over present-day systems, and a possibility of wrong selection in the event that the long impulses are interchanged with the short impulses. These conclusions are erroneously drawn because the paper is quite clear in outlining that accuracy of selection is not sacrificed and in addition selection time reduced. The Westinghouse company has pioneered the art of remote control and at its very inception held gospel the fact that accuracy of selection in a successful remote control system must be maintained at any expense. The self-checking system maintains this fundamental.

There is no statement or inference in the article indicating that the number of relays are increased over and above present-day systems. While it is also a fact the article does not deal with the number of relays involved in large systems, the actual over-all number of relays is reduced over present-day systems.

The interchange of short impulses with long impulses can produce no adverse effects because if such a code is produced when originated either by the dispatcher or an automatic operation the completed operation cannot be performed because in the first place the selection will not indicate on the point as operated by the dispatcher. Therefore reselection must be made. In the case of an automatic operation the point selected is not in agreement with the device which operated automatically and consequently the restoring circuit is not established and the equipment automatically resets and retransmits the correct code.

Very truly yours,
G. De Croce

(Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.)

Personal Items

D. C. Jackson (A'87, F'12) has been awarded the AIEE Edison Medal for 1938. The award, highest in electrical engineering, was made to Doctor Jackson "for outstanding and inspiring leadership in engineering education and in the field of generation and distribution of electric power." Born at Kennett Square, Pa., February 13, 1865, Doctor Jackson received the degrees of bachelor of science and civil engineer from Pennsylvania State College, subsequently pursuing post graduate study in electrical engineering at Cornell University for two years. In 1932 he was granted the honorary degree of doctor of science by Columbia University; Northeastern University has conferred upon him the honorary degree of doctor of engineering. Doctor Jackson's early engineering experience was gained as vice-president and engineer, 1887–89, for the Western Engineering Company, Lincoln, Neb., which was engaged in the design and construction of electric light and power plants and distribution systems. He was assistant chief engineer with the Sprague Electric Railway and Motor Company, New York, 1889–91, and later was chief engineer for the central district of the Edison General Electric Company, supervising in these positions the design and construction of many electric railway and power plants. In 1891, he formed a consulting engineering firm, and also became professor of electrical engineering at the University of Wisconsin, which position he retained until 1907, when he was appointed professor and head of the department of electrical engineering at Massachusetts Institute of Technology, Cambridge. In 1919 the consulting engineering firm of Jackson and Moreland, specializing in railway electrification and electric power production and distribution, was organized, with Doctor Jackson as senior partner, a position which he retained until 1930. He retired as professor emeritus at Massachusetts Institute of Technology in 1935. Doctor Jackson's broad vision, his untiring efforts, and his outstanding qualifications as a leader of men not only have produced a high reputation in both engineering practice and education, but also have made him the recipient of many notable honors, including the Lamme Medal of the Society for the Promotion of Engineering Education in 1931, and election as president of that society for 1905–06. He accepted an invitation from the Institute of Electrical Engineers of Japan to give a series of lectures in Japan in 1935, under the Iwadare Foundation. Doctor Jackson is chairman of the AIEE committee on code of principles of professional conduct, on which he has served since 1936, and at various times has been member or chairman of many of the Institute's other committees. He was a vice-president of the AIEE from 1897 until 1899, and was president during 1910–11. At present he is a member of the committee on legislation affecting the engineering profession and the committee on standards. Doctor Jackson served as lieutenant colonel of engineers in France during the World War; president of the Boston Society of Civil Engineers 1922–23; member of the international jury, Chicago Exposition, 1893, and Buffalo Exposition, 1901; United States Government delegate to the World Engineering Congress, Tokyo, 1929; and member of the board of investigation and coordination of the Society for the Promotion of Engineering Education. He is a chevalier, Legion of Honor (France), president of the American Academy of Arts and Sciences, and a member of the American Physical Society, American Society of Civil Engineers, The American Society of Mechanical Engineers, Institution of Electrical Engineers (London), Société Française des Électriciens (Paris), American Institute of Consulting Engineers, of which he was president in 1938 and other societies. He is the author of five books on electrical engineering, and approximately 150 articles related to engineering projects and engineering education.

C. E. Rogers (A'11, F'36) on November 1, 1938, became system plant results engineer for The Pacific Telephone and Telegraph Company with headquarters in San Francisco, Calif. Formerly he had been chief engineer of that company's Washington-

Idaho area with offices at Seattle. Mr. Rogers has been in telephone work for more than 36 years and is credited with having brought about many important developments in connection with telephone engineering on the Pacific Coast. He was first with the Mutual Automatic Telephone Company in New Mexico, later in Colorado, and then with the Bay City Telephone Company in Oakland, Calif. Except for a brief experience with Western Electric Company in 1929, Mr. Rogers has been continuously with The Pacific Telephone Company since 1912. He is a past vice-president of the AIEE (1936–38) and past chairman of the Seattle section (1934–35). He recently served on the Edison Medal and other national committees and currently is serving on the committee on communication. Mr. Rogers was graduated from the University of New Mexico in 1909 and was John W. Mackay Jr. Fellow in electrical engineering at the University of California in 1909–10 from which university he received a master of science degree in electrical engineering in 1910.

E. R. Shute (A'17) has been appointed vice-president in charge of traffic of the Western Union Telegraph Company, New York, N. Y. Born May 26, 1889, at Coal City, Ind., Mr. Shute was graduated from Purdue University in 1912 with the degree of bachelor of science in electrical engineering and immediately entered the service of the Western Union Telegraph Company as engineering assistant to the traffic engineer. In 1917 he became assistant traffic engineer; general supervisor of traffic and costs in 1919; operating engineer in 1921; and in 1929 became general superintendent of traffic. Since joining the Western Union Telegraph Company, Mr. Shute has been closely associated with the development and application of new forms of printing telegraphs. He is a member of the AIEE committee on communication, the Radio Club of America, an affiliated member of the telegraph and telephone section of the Association of American Railroads, and a member and past director of the Institute of Radio Engineers.

E. D. Uhlendorf (A'13) has been elected vice-president and director of the Public Utility Engineering and Service Corporation, Chicago, Ill. Mr. Uhlendorf was born at Chicago in 1887, and attented the Armour Institute of Technology. He has been associated with Public Utility Engineering and Service Corporation and its predecessor, the Byllesby Engineering and Management Corporation, continuously since 1911, with the exception of a three-year period during which he was engaged in special public-utility evaluation work. Mr. Uhlendorf became a member of the operating committee of the Byllesby Corporation in 1925, and was appointed executive engineer of the Public Utility Engineering and Service Corporation in 1937.

M. R. Woodward (A'11, M'18), who has been made chief engineer of the Marblehead Lime Company, Chicago, Ill., was graduated from George Washington University with a bachelor of science degree in electrical engineering in 1905 and was awarded the degree of electrical engineer in 1908. He was instructor and assistant professor of electrical engineering at that university for eight years. His engineering experience covers 10 years of industrial and power engineering, Bureau of Yards and Docks, Navy Department, Washington, D. C.; 16 years as assistant chief engineer of the Lehigh Portland Cement Company, Allentown, Pa.; and 6 years in promoting pulverizer sales to the cement industry for Babcock and Wilcox Company, Chicago, Ill. Mr. Woodward was chairman of the AIEE Lehigh Valley Section in 1927–28 and served on the committee on general power applications for the past ten years, as chairman from 1933–36. He also was a member of the technical program committee from 1933–36.

A. P. M. Fleming (M'14, F'34) has been elected president of the British Institution of Electrical Engineers for 1938–39. Born in 1881 at Newport, Isle-of-Wight, he received his technical education at Finsbury Technical College, London, England, graduating with the degree of master of science. In 1900 he joined the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., and two years later returned to England to enter the service of the Metropolitan-Vickers Electrical Company (formerly the British Westinghouse Company), first as insulation specialist and later as superintendent and chief engineer of the transformer department. Since 1914 he has been in charge of research and education and is now director and manager of this department of the Metropolitan Vickers company. Doctor Fleming is local honorary secretary in England of the AIEE, and is a fellow of the Institute of Patentees and a member of the Institution of Mechanical Engineers. He also holds the honorary degrees of master of science, Manchester, and doctor of engineering, Liverpool. Doctor Fleming has written numerous articles for various technical and educational journals, in addition to five books.

G. A. Burnham (A'03) has resigned as assistant manager of the electrical department, in charge of switchgear sales and engineering division of the Condit Works of the Allis-Chalmers Manufacturing Company, Boston, Mass. A native (1882) of Essex, Mass., Mr. Burnham was engaged in electrical construction work until 1904. From 1904 to 1908 he was employed by the General Electric Company, in the latter year becoming design engineer. In 1909 Mr. Burnham became chief engineer in charge of design for the Condit Electrical Manufacturing Company, South Boston, and in 1923 was made general manager. Later when the Condit Electrical Manufacturing Company was purchased by the American Brown-Boveri Electric Corporation, Mr. Burnham was elected president of the electrical subsidiary, the American Brown-Boveri Company, Inc. After the purchase by Allis-Chalmers, Mr. Burnham continued as president and treasurer of the Condit Electrical Manufacturing Corporation until January 1, 1937, after which the Condit plant was operated as a branch of the Allis-Chalmers Manufacturing Company, and Mr. Burnham was made assistant manager of the electrical department. In the future Mr. Burnham will be retained in a consulting capacity.

T. F. Barton (A'12, F'30) has been appointed assistant manager of the New York district of the General Electric Company. A native (1885) of Orangeburg, S. C., Mr. Barton is a graduate of Clemson Agricultural College, where he received the degree of bachelor of science in electrical engineering. He entered the testing department of the General Electric Company, Schenectady, N. Y., in 1906 and was transferred to the d-c engineering department in 1909. From 1911 to 1912 he was engaged in construction engineering work for the New York district of the company, and served in the engineering department of the New York office until 1917. Mr. Barton then returned to Schenectady as a member of

D. C. JACKSON

C. E. ROGERS

E. R. SHUTE

E. D. UHLENDORF

M. R. WOODWARD

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the central station engineering department, remaining there until 1927 when he became district engineer for the New York district. Mr. Barton has twice won Charles A. Coffin Foundation awards for outstanding contributions to the electrical industry, and in 1932–33 was chairman of the New York Section of the AIEE. At present he is chairman of the AIEE winter convention committee.

W. S. Edsall (M'19) has been appointed assistant manager of the electrical department, in charge of switchgear sales and engineering division of the Condit Works of the Allis-Chalmers Manufacturing Company, Boston, Mass. Born May 17, 1890, at Bozeman, Mont., Mr. Edsall was graduated from Montana State College in 1911 with the degree of bachelor of science, and received that of electrical engineer from the University of Montana in 1914. He entered the employ of the Condit Electric Manufacturing Company, Boston, in 1920 and was made sales manager in 1922. He was appointed general manager of the American Brown-Boveri Company in 1928, and also a director of Condit Electric Manufacturing Corporation. When Allis-Chalmers Manufacturing Company purchased these companies in 1931, Mr. Edsall continued his connection with them as manager of sales for the Condit Works and later for the switchgear division, with headquarters at Condit Works.

G. M. L. Sommerman (A'31, M'37) research engineer for the American Steel and Wire Company, Worcester, Mass., has received honorable mention in the selection by Eta Kappa Nu, honorary electrical engineering society, of America's outstanding young electrical engineer for 1938. Doctor Sommerman was born July 2, 1909, at Baltimore, Md., and received the degrees of bachelor of engineering (1929) and doctor of engineering (1933) at The Johns Hopkins University. In 1934 he joined the research engineering staff of the American Steel and Wire Company, where he has been in charge of fundamental researches on properties of materials for use in high-voltage cables. Doctor Sommerman is a member of the Institute's committees on research and instruments and measurements. He has made many contributions to the technical literature of dielectrics, and received the Alfred Nobel Prize for 1937. He is a member of several technical and honorary societies.

E. B. Merriam (A'06, M'23) has resigned from active service as engineer in the switchgear division of the General Electric Company, Philadelphia, Pa., to engage in industrial consulting work in New Haven, Conn. A native (1880) of New Haven, Mr. Merriam received his education in various private schools, and in 1903 became affiliated with the General Electric Company at Schenectady, N. Y., as testing and field engineer in the switchgear engineering department. In 1905 he was transferred to the designing department, two years later becoming assistant engineer in charge of design in the switchboard department. Mr. Merriam became director of industrial service at the Schenectady works in 1917, and executive engineer in 1922. Mr. Merriam is still retained by the General Electric Company in a consulting capacity. He has been a member of the Institute's committees on the Edison Medal, education and membership, and was vice-president 1928–30.

H. E. Gove (A'31) electrical engineer of the Union Electric Company, St. Louis, Mo., has received honorable mention in the selection by Eta Kappa Nu, honorary electrical engineering society, of America's outstanding young electrical engineer for 1938. Mr. Gove is a native (1905) of Linn, Mo., and was graduated from the University of Missouri in 1929 with the degree of bachelor of science in electrical engineering. Following this he went as a student engineer with the Union Electric Light and Power Company, where he is now employed in the power supervision department. While maintaining his regular work, Mr. Gove continued with his educational pursuits, obtaining his master's degree in mathematics at Washington University in 1935. He has been active in the AIEE St. Louis Section, and is a member of Sigma Xi, Eta Kappa Nu, Tau Beta Pi, Pi Mu Epsilon, and The American Mathematical Society.

W. C. Plumer (A'24, M'30) has been appointed engineer of the Buffalo, N. Y., office of the General Electric Company. Mr. Plumer was born September 5, 1897, at Portland, Me., and was graduated from the University of Maine in 1921 with the degree of bachelor of science in electrical engineering, receiving the degree of electrical engineer in 1926. Mr. Plumer entered the student test course of the General Electric Company, Schenectady, N. Y., in 1921, and in 1922 was made foreman in charge of motor testing. From 1923 to 1928 Mr. Plumer served in the industrial control engineering department, and in the latter year entered the industrial engineering department. In 1929 he became engineer of the Newark, N. J., office of the General Electric Company, which position he retained until his present transfer.

S. R. Schealer (A'13, M'23) has been made professor of electrical engineering and acting chairman of the department of electrical engineering at Vanderbilt University, Nashville, Tenn. A native of Reading, Pa., Professor Schealer was graduated from Lehigh University in 1909 and for 15 years was instructor, assistant professor, and associate professor of electrical engineering at that university. From 1927 to 1935 he was professor of electrical engineering and chairman of the department at Duke University, Durham, N. C. During the World War Professor Schealer served as a lieutenant in the United States Navy for two years. He is a member of Phi Betta Kappa, Tau Beta Pi, Eta Kappa Nu, and the Society for the Promotion of Engineering Education.

J. D. Mortimer (A'00) member of the executive committee of the North American Company, New York, N. Y., has resigned as director of that company and its subsidiaries, North American Edison Company and Union Electric Company of Missouri. He also has resigned as vice-president of the latter company. Mr. Mortimer was made president of the North American Company in 1914, serving until his resignation in 1920. He is a native of Elmhurst, Ill., and received his technical education at Throop Polytechnic Institute (now California Institute of Technology), Pasadena, and the University of California, Berkeley, receiving the degree of bachelor of science in mechanical engineering in 1900. He is a member of several technical and honorary engineering societies.

O. S. Mitchell (A'23, M'30) has relinquished his duties as editorial director for Hugh C. MacLean Publications, Ltd., Toronto, Ont., Canada, to become acting secretary of the Hydro-Electric Power Commission of Ontario. A native (1902) of London, England, Mr. Mitchell received his technical education in England prior to joining the electrical-engineering staff of the Hydro-Electric Power Commission of Ontario in 1923. He resigned to become assistant editor of *Electrical News and Engineering* in 1927, and was appointed editor a few years later. He was appointed to his recent position as editorial director in 1935, continuing also as managing editor of *Electrical News and Engineering*. Mr. Mitchell is a member of the executive committee of the AIEE Toronto Section.

A. R. Robison (A'12, M'20) has been made city manager of Celina, Ohio. Mr. Robison was graduated from the University of Minnesota in 1909 and was active on hydroelectric developments in the Rocky Mountain states for a number of years. In 1918 he became associated with the J. G. White Engineering Corporation, serving as that company's assistant construction superintendent at United States Nitrate Plant Number 2, Muscle Shoals, Ala. Since its inception Mr. Robison has been vice-president and general manager of the Central Ohio Light and Power Company in its main office at Findlay, Ohio.

F. R. Lack (M'37) has been appointed general commercial engineer of the Western Electric Company, New York, N. Y. Mr. Lack was born July 18, 1895, at Eastbourne, England, and received the degree of bachelor of science from Harvard University in 1925. He served in the division of research and inspection of the Signal Corps of the United States Army 1917–18, and was then employed in the engineering department of the Western Electric Company in China. He attended Harvard University from 1923 to 1925, and in the latter year became a member of the technical staff of the Bell Telephone Laboratories, Inc., which position he retained until 1935, when he was appointed vacuum tube development director.

R. A. Jones (A'20) has been appointed assistant engineer for the General Electric Company, New York, N. Y. A native (1892) of Wabasha, Minn., Mr. Jones was graduated from the University of Minnesota in 1916, with the degree of electrical engineer. He was engaged in electrical construction until 1916, when he entered the testing department of the General Electric Company, Schenectady, N. Y., and was transferred to the power and mining engineering department in the following year. Mr. Jones became associated with the industrial engineering department at Schenectady in 1918, and was appointed engineer for the Syracuse, N. Y., office in 1923. He had been at the Buffalo, N. Y., office as engineer since 1936.

D. G. Evans (A'20) has been appointed vice-president of the Wisconsin Gas and Electric Company, Kenosha. A native (1887) of Larned, Kans., Mr. Evans was graduated from the University of Illinois in 1917 with the degree of bachelor of science in electrical engineering. His early experience was gained in the transformer test department of the Wagner Electric Manufacturing Company and in central-station work. He entered the employ of the Wisconsin Gas and Electric Company as engineer in 1919. Mr. Evans was made general manager of the Wisconsin utility in 1937, after having served as assistant general manager.

L. F. Stone (A'23, M'30) has been appointed engineer at the Newark, N. J., office of the General Electric Company. A native (1899) of Otter River, Mass., Mr. Stone was graduated from Worcester Polytechnic Institute in 1920. He then entered the test course of the General Electric Company at Schenectady, N. Y., and in 1921 was transferred to the switchboard department. In 1922 Mr. Stone went to the engineering department of this company in New York, N. Y., and in 1925 became field engineer of switchgear and industrial control devices, in which position he remained until his present appointment.

H. L. Logan (A'19, M'28) has been appointed managing engineer of the newly organized Controlens Division of the Holophane Company, New York, N. Y. Mr. Logan received his engineering education at the Institute of Polytechnics, Birmingham, England. Since 1919 he has been with the Holophane Company, first as assistant to the chief engineer, then as field engineer, district manager, and since 1932 as engineering consultant. He has been awarded a variety of patents in the illuminating field and is responsible for the development of many of the electric lighting devices now in wide commercial use.

E. T. Ankele (A'30) has been named as general superintendent of operations of the Lower Colorado River Authority. He will be in charge of production and distribution of power, the physical operations of the system, and maintenance. A native (1894) of Dallas, Texas, he became a student engineer with the Stone and Webster Engineering Corporation in 1913. In 1916 he entered the operating department of the Texas Power and Light Company, and in 1926 entered the operating department of the Central Power and Light Company at San Antonio, where he served as superintendent of transmission.

J. E. Sheehan (A'28, F'33) has become associated with the transformer division of the Line Material Company and will act as sales engineer in the South, with headquarters at Houston, Texas. Born March 9, 1892, at Montrose, Colo., Mr. Sheehan was graduated from Colorado College in 1913 with the degree of bachelor of arts, later taking graduate work at Leland Stanford Jr. University. He was employed by the Phoenix Utility Company and the Texas Construction Company prior to his appointment in 1924 as chief engineer of the Houston Lighting and Power Company, Houston, Texas.

W. C. Schumacher (A'35) Brooklyn, N. Y., has accepted employment as a junior electrical engineer in the United States Civil Service. He formerly was employed in the service department of the export division of General Motors Corporation at New York.

E. E. Wyland (A'29) who has been plant superintendent for the Denver, Colo., district of the Mountain States Telephone and Telegraph Company, has been transferred to Boise, Idaho.

D. S. Healey, Jr. (A'37) has been appointed manager of the Columbus, Ohio, district of the Locke Insulator Corporation. He was formerly sales engineer in that company's Pittsburgh, Pa., office.

Obituary

Arthur Hamilton Lawton (A'03, F'19) manager of the engineering department of the Canadian and General Finance Company, Ltd., Toronto, Ont., Canada, died December 2, 1938. Mr. Lawton was born March 7, 1879 at Red Bank, N. J., and was graduated from Union College in 1900 with the degree of bachelor of science in electrical engineering. He entered the testing department of the General Electric Company, Schenectady, N. Y., in 1900, and later served in the drafting and switchboard departments of that company. From 1903 to 1905 Mr. Lawton worked as assistant electrical engineer for the Hudson River Water Power Company at Glens Falls, N. Y., and in the latter year joined the New York Edison Company where he remained for 12 years, 3 years as assistant to the chief electrical engineer and 9 years as assistant chief electrical engineer. In 1917 he joined Hodenpyl, Hardy and Company, New York, as assistant chief engineer and manager of construction department of the Consumers Power Company, Jackson, Mich. Mr. Lawton joined the Canadian and General Finance Company, Toronto, Ont., Can., in 1922 as manager of the engineering department. He was a member of the American Institute of Mining and Metallurgical Engineers, Canadian Electrical Association, and Sigma Xi.

Harry Clinton Abell (A'03) retired vice-president of the Electric Bond and Share Company, died at New Orleans, La., November 24, 1938. He was born at Winnipeg, Man., Canada, July 8, 1871, and was graduated from Armour Institute of Technology as a bachelor of science in electrical engineering in 1897. He began his business career as an apprentice with the Canadian Pacific Railway and later worked for the Belding Motor Company of Chicago, the Canadian General Electric Company, the Anchor Line, and the International Navigation Company. Following service during the Spanish-American War, he joined Emerson McMillin and Company, an early firm in the supervising of public utility companies. Mr. Abell became a vice-president of the Electric Bond and Share Company when he joined the system in 1921, and served as president of the National Power and Light Company from the time of its formation in 1925 until his retirement from active business in 1933. He also relinquished his position as director of National Power and Light Company, vice-president and director of Electric Power and Light Corporation, director and chairman of the Memphis Power and Light Company and vice-president and director of the New Orleans Public Service Company. A past-president of the American Gas Association and a former treasurer of the National Electric Light Association, Mr. Abell was a member of several engineering societies.

Clift Button Keyes (A'03, M'30) district manager, transportation department, General Electric Company, New York, N. Y., died December 7, 1938. Born August 24, 1877, at Terre Haute, Ind., Mr. Keyes was graduated from Rose Polytechnic Institute in 1899 with the degree of bachelor of science in electrical engineering. He immediately entered the testing department of the General Electric Company at Schenectady, N. Y., and in 1901 was assigned to the construction department. He was transferred to the railway engineering department in 1907, and in the following year was moved to the engineering department of the company's New York office. In 1924 he became assistant manager, and in 1925 manager, of the district office's railway department which in 1929 was reorganized to become the transportation department with Mr. Keyes as manager. He was extremely active in the electrification of the New York Central Terminal, and was a member of numerous railroad organizations and engineering societies.

Hans Edward Aaronsen (A'07), general manager of A/S Tyssefaldene of Tyssedal, Norway, died recently. He was born in Arendal, Norway, June 6, 1879. Mr. Aaronsen was graduated from high school and technical school in Norway and took two years of college work at Karlsruhe, Germany. For several years he was a designer for the Niagara Lockport & Ontario Power Company of Buffalo, N. Y., and during his residence in the United States was also associated with Cass Gilbert, architect, New York, N. Y.; the Lacklede Power Company, St. Louis, Mo.; and the Heintze Electric Co., Lowell, Mass. From 1918 until his death Mr. Aaronsen was with A/S Tyssefaldene.

Leigh Rush Gillespie (A'19, M'35) telephone engineer, Rochester Telephone Corporation, Rochester, N. Y., died in November 1938. He was born at Spencer, Iowa, March 30, 1880, and was graduated from Iowa State College in 1905 with the degree of bachelor of science in electrical engineering. Following graduation he entered the employ of the Stromberg Carlson Telephone Manufacturing Company, Rochester, a company with which he was affiliated until 1920, except for the period 1912–14, when he was with the Northern Electric Company, Montreal, Que., Canada. In 1920 Mr. Gillespie entered the employ of the Rochester Telephone Company, which later became the Rochester Telephone Corporation. Mr. Gillespie served as secretary of the AIEE Rochester Section, 1932–33 and 1935–36 and as vice-chairman of the Section 1933–34.

John Henry Thompson (A'21), recently appointed to the position of technical counselor to the Canadian Marconi Company, Montreal, Que., Canada, died October 31, 1938. Mr. Thompson had been chief engineer of the company for 17 years. Born at Durham, England, September 15, 1883, he obtained his education and early experience in that country. In 1910 he entered the test department of the Canadian General Electric Company at Peterboro, Ont., and four years later accepted a position in the radiotelegraph branch of the Department of Naval Service, Ottawa, subsequently becoming chief engineer of the Canadian Government Radio Service. Mr. Thompson retained the latter position until he became associated with the Canadian Marconi Company. He attended the International Radio Conference at Washington, D. C., in 1927 and at The Hague in 1929.

Joseph Ellis (A'17) assistant superintendent of power, Philadelphia Rapid Transit Company, Philadelphia, P.a, died October 2, 1938. Mr. Ellis was born April 21, 1878, near Durham, England. In 1894 he was employed by the Philadelphia Rapid Transit Company and remained continuously in its service until the time of his death. Starting in the roadway department he was transferred to the electrical department in 1901. His practical experience was supplemented by night and correspondence school courses. From electrician, Mr. Ellis advanced, through successive positions, to assistant superintendent of power in 1930. A practical electric-railway operating and maintenance engineer, his service consisted principally of supervising operation and maintenance of power generation and substation equipment. Mr. Ellis took a valuable part in the modernization of substation equipment employed in the electric railway field from 1901 to 1938.

Walter Hossie Hoppe (A'30) junior consulting engineer, General Railway Signal Company, Rochester, N. Y., died in November 1938. Mr. Hoppe was born at Baltimore, Md., May 15, 1906, and was educated at Northwestern University and Massachusetts Institute of Technology, from which he received the degree of bachelor of science in electrical engineering in 1928. During 1928–29 he was employed by the Public Service Company of Northern Illinois and the Commonwealth Edison Company, Chicago. Since 1929 he had been employed by the General Railway Signal Company at Rochester, where he started as electrical engineer.

Lloyd Melvin Killgore (A'18) electrical engineer for the General Electric Company, Oakland, Calif., died in March 1938 according to word just received at Institute headquarters. Born in 1889 at Longmont, Colo., Mr. Killgore was graduated in 1910 from the Colorado State Agricultural College, receiving the degree of bachelor of science in electrical engineering. He then entered the test course of the General Electric Company and in 1912 was transferred to the transformer engineering department where he was employed as designing and development engineer for six years. Mr. Killgore became electrical engineer for the company at Pittsfield, Mass., in 1918, and in 1927 was transferred to their Oakland, Calif., office in this same capacity.

Francis William Gallagher (A'37) relay testman, General Electric Company, Philadelphia, Pa, died September 18, 1938. A native of Philadelphia, where he was born September 15, 1913, Mr. Gallagher was graduated from Villanova College in June 1936 with the degree of bachelor of science in electrical engineering. He was employed as a guide at The Franklin Institute in Philadelphia prior to his employment by the General Electric Company.

Membership

Recommended for Transfer

The board of examiners, at its meeting on December 15, 1938, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

Brand, F. F., assistant to manager in charge of engineering, General Electric Company, Pittsfield, Mass.
Gamble, L. R., electrical engineer, The Washington Water Power Company, Spokane.
Heising, R. A., radio research engineer, Bell Telephone Laboratories, Inc., New York, N. Y.
Korner, A. J., consulting engineer, Stockholm, Sweden.

4 to Grade of Fellow

To Grade of Member

Bell, Adam, statistical engineer, Toronto Hydro-electric System, Toronto, Ont., Can.
Bretschneider, M. E., foreman of laboratory, Kansas City Power & Light Company, Kansas City, Mo.
Bush, G. L., engineer, The Teleregister Corporation, New York, N. Y.
Griffith, L. A., electrical engineer, Minneapolis Honeywell Regulator Company, Minneapolis, Minn.
Jones, E. C., assistant professor of electrical engineering, West Virginia University, Morgantown.
Price, C. A., chief engineer, Canadian Westinghouse Company, Ltd., Hamilton, Ont., Can.
Rudge, W. J., electrical engineer, General Electric Company, Pittsfield, Mass.
Zehner, R. W., electrical engineer, Elliott Co., Ridgway, Pa.

8 to Grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before January 31, 1939, or March 31, 1939, if the applicant resides outside of the United States or Canada:

United States and Canada

Beck, M. W., Bureau of Power and Light, Los Angeles, Calif.
Beharka, M., United States Rubber Products, Inc., Passaic, N. J.
Benesh, E. J., Western Electric Company, Kearny, N. J.
Blankmeyer, W. H., Radio Engineering and Service Company, Butte, Mont.
Boice, W. K., General Electric Company, Schenectady, N. Y.
Bowles, C. E., Kansas Gas and Electric Company, Arkansas City, Kans.
Broaddus, P. H., Loupe River Public Power District, Columbus, Nebr.
Carnie, W. B., Montaup Electric Company, Fall River, Mass.
Cartland, F. W. (Member), Michigan College of Mines and Technology, Houghton.
Collins, C. L., Boulder Power Plant, Boulder City, Nev.
Connell, M. M., Pyle National Company, Merwood Park, Upper Darby, Pa.
Cook, L., Delgado Trades School, New Orleans, La.
Crocker, F. F., Nevada-California Electric Corporation, Palm Springs, Calif.
Davis, A. H., United States Bureau of Reclamation, Denver, Colo.
Donnelly, H. J., New York Telephone Company, Troy.
Dugan, D. J., E. G. Budd Manufacturing Company, Philadelphia, Pa.
Dzung, L. S., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Eick, R. W., Los Angeles Bureau of Power and Light, Boulder City, Nev.
Fairley, G. E. A. (Member), Public Safety, City of Pittsburgh, Pa.
Fullerton, R. McN., Saguenay Power Company Ltd., Arvida, Que., Canada.
Funston, I. D., E. G. Budd Manufacturing Company, Philadelphia, Pa.
Gilbert-Carter, J. C. (Member), 447 Marlborough Street, Boston, Mass.
Glover, H. A., Robert E. Brown Company, Pittsburgh, Pa.
Green, L. G., Loup River Public Power District, Columbus, Nebr.
Griffith, D. A., Allis Chalmers Manufacturing Co., Pittsburgh, Pa.
Gunzburger, E., Houston Lighting and Power Company, Houston, Tex.
Hannum, W. T., Pacific Gas and Electric Company, San Francisco, Calif.
Harmon, J. L., Cleveland Electric Illuminating Company, Cleveland, Ohio.
Haynes, T. E., Tennessee Valley Authority, Guntersville Dam, Ala.
Hewitt, C. D., Jr., 60 Harmon St., Hamden, Conn.
Hill, T. W., Hugh C. MacLean Publications Limited, Toronto, Ont., Canada.
Hull, P. B., Public Service Company of Colorado, Denver.
Jewett, H. L., Potomac Electric Power Company, Washington, D. C.
Keirstead, E. W., 74 Stewart Avenue, Mansfield, Ohio.
Kuehn, T. C., E. G. Budd Company, Philadelphia, Pa.
Lapidos, R. H., National Carbon Co., Fostoria, Ohio.
Linthicum, J. M., Chesapeake and Potomac Telephone Company, Washington, D. C.
Loomis, R. O., Georgia Power Company, Atlanta.
Meisse, L. A., Ohio Brass Company, Mansfield.
Melville, C. E., Hickok Electrical Instrument Company, Cleveland, Ohio.
Moschel, M. A., Commonwealth Edison Company, Chicago, Ill.
Nagle, C. F. (Member), Scranton Electric Company, Scranton, Pa.
Olmstead, H. M., General Electric Supply Corporation, Denver, Colo.
Overbeck, W. P., Raytheon Production Corporation, Waltham, Mass.
Pansini, A. J. (Member), Consolidated Edison Company of New York Inc., New York.
Parker, O. J., Louisiana Power and Light Company, Sterlington.
Phillip, H. J. (Member), Bureau of Power and Light, Los Angeles, Calif.
Quance, T. S. G., Hydro Electric Power Commission of Ontario, Toronto, Ont., Canada.
Rooney, G. J. A., H. M. Hopper Company Ltd Saint John, N. B., Canada.
Schager, R. J., Indiana Bell Telephone Company, Indianapolis.
Schmitt, L. P., Joslyn Company, New York, N. Y.
Schrader, G. D., Philadelphia Electric Company, Philadelphia, Pa.
Seem, D. A., Reda Pump Company, Bartlesville, Okla.
Selvidge, H., Kansas State College, Manhattan.
Seymour, C. E., Metropolitan Water District of Southern California, Indio, Calif.
Smith, C. A., Pacific Telephone and Telegraph Company, San Francisco, Calif.
Smith, J. E., RCA Communications Inc., New York, N. Y.
Somerville, G. G., General Electric Company, Pittsfield, Mass.

Speer, P. B., Northern States Power Company, Minneapolis, Minn.
Thomas, G. G., Western Electric Company, Denver, Colo.
Thomas, T. D., Texas Power & Light Company, Dallas.
Titus, M. C., United States Bureau of Reclamation, Roza Project, Yakima, Wash.
Toomey, E. M. (Member), Consolidated Edison Company of New York, New York.
Vidmar, F., Jr., Hickok Electrical Instrument Company, Cleveland, Ohio.
Wagner, L. C. H., 2377 S.W. 24 Terrace, Miami, Fla.
Waldeis, P. C. (Member), Alhart Electric Company Inc., Rochester, N. Y.
Wear, E. G., Public Service Company of Northern Illinois, Chicago, Ill.
Whitehead, E. G., Potomac Electric Power Company, Washington, D. C.
Willox, J. H., Joslyn Manufacturing and Supply Company, Chicago, Ill.

Total, United States and Canada—69

Elsewhere

Baynton, E. W., Warburton and Franki Limited, Sydney, N.S.W., Australia.
Bhattacharyya, P. K., Tata Iron & Steel Company Ltd., Jamshedpur, India.
Heinrich, H., Hawaiian Electric Company Ltd., Honolulu, Territory of Hawaii.
Hughes, C. P. (Member), Hackbridge Electric Construction Company Ltd., and Hewittic Electric Company, Ltd., Walton on Thames, England.
Krivor, M. G., General Electric Company, Hongkong, China.
Lim, V. F. (Member), National Power Corporation, Manila, P. I.
Markland, J. D. (Member), Central London Electricity Ltd., London, S.W. 7, England.
Marshall, L. B., Westmorland and District Electricity Supply Company Ltd., Carnforth, Lancashire, England.
Ram, R., Rakha Ram and Company, Jullundhur City, India.
Spector, D., 16 K. K. L. Boulevard, Tel-Aviv, Palestine.
Stace, F. N., Technical Publications Limited, Wellington, New Zealand.
Swami, T. V. (Member), Ramkote, Hyderabad-Deccan, India.
Vaidya, V. R., Tata Power Company Ltd., Fort Bombay, India.

Total elsewhere—13

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the addresses as they now appear on the Institute record. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the secretary at 33 West 39th St., New York, N. Y.

Bertolacci, R. L., 721 Brighton Road, Pittsburgh, Pa.
Black, Kenneth H., 916 Yale Ave., S., Seattle, Wash.
Cory, Harold M., 270 Washington Ave., Albany, N. Y.
Gademann, Oscar M., Stuttgarterplatz 1A-11 Berlin-Charlottenburg, Germany
Hutchison, Paul C., 529 N. 13th St., Milwaukee, Wis.
Hyman, Stanley L., 156 Medway St., Providence, R. I.
Straley, Munro R., Soldier, Pa.
Van Bylevelt, J. S., 220 E. 204th St., New York, N. Y.

8 Addresses Wanted

Engineering Literature

New Books in the Societies Library

Among the new books received at the Engineering Society Library, New York, recently are the following which have been selected because of their possible interest to the electrical engineer. Unless otherwise specified, books listed have been presented gratis by the publishers. The Institute assumes no responsibility for statements made in the following outlines, information for which is taken from the preface of the book in question.

LEBENSERINNERUNGEN von WERNER von SIEMENS. Thirteenth edition. Berlin, Julius Springer, 1938. 298 pages, illustrated, diagrams, 10 by 6 inches, cloth, 3.90 rm. Werner von Siemens's "personal recollections" contain much of interest to engineers, especially concerning the infancy of the electrical industry. First published in 1892, the book has been re-issued frequently.

ATM—Archiv für Technisches Messen. Lieferungen 85–87, July–Sept. 1938. Munich and Berlin, R. Oldenbourg, illus., 12 by 8 in., paper, 1.50 rm. each. Three numbers of a monthly publication containing classified articles upon various types of apparatus and methods for technical measurements. Certain numbers also contain descriptions of specific instruments manufactured by German companies.

AIR CONDITIONING for COMFORT. By S. R. Lewis. 3 ed. Chicago, Keeney Publishing Co., 1938. 285 p., illus., 9 by 6 in. cloth, $2.50. A general treatment of the field, covering thermodynamical and physical fundamentals, heat transmission, heating and air conditioning systems, refrigeration systems and refrigerants, air distribution and noise control. A final brief chapter includes certain codes and regulations.

CERAMIC TRADE DIRECTORY, Official Directory of Ceramic Whiteware and Allied Plants in United States and Canada. 5 ed. 1938. Newark, N. J., Ceramic Publishing Co., 1938. 248 p., 7 by 5 in., lea., $6.00. Lists the American ceramic whiteware and allied plants, giving information as to location, products, equipment, capacity, and officers.

ECONOMICS for ENGINEERS. By E. L. Bowers and R. H. Rowntree. 2 ed., N. Y. and Lond., McGraw-Hill Book Co., 1938. 591 p., illus., 9 by 6 in., cloth, $4.00. A practical presentation of economic principles for engineers and engineering students, in which the subject is treated as concisely as possible and the engineering aspects of economic theory and business activity are emphasized.

ESTIMATES and COSTS of CONSTRUCTION. By F. W. Stubbs, N. Y. John Wiley & Sons, 1938. 234 p., illus., 9 by 6 in., cloth, $3.00. Outlines some of the important steps in the development of a construction project especially the preliminary financial investigations and the studies that must be made before and during the actual construction. Only enough cost data to illustrate the discussion are included.

FORMULAS for STRESS and STRAIN. By R. J. Roark. N. Y. and Lond., McGraw-Hill Book Co., 1938. 326 p., illus., 9 by 6 in., cloth, $3.00. Brings together the formulas, facts, and principles pertaining to the strength of materials which are required in the more precise and accurate methods of stress analysis imposed by modern engineering trends.

Great Britain. Mines Dept. REPORT of H. M. ELECTRICAL INSPECTOR of MINES for the year 1937. London, His Majesty's Stationery Office, 1938. 48 p., illus., 10 by 6 in., paper, (obtainable from British Library of Information, 270 Madison Ave., New York, $.35). In addition to statistics on the electrical equipment used, the report contains descriptions of the accidents attributed to the use of electricity.

STANDARDS on ELECTROACOUSTICS. 1938. 37 p. STANDARDS on ELECTRONICS. 1938. 59 p. STANDARDS on RADIO RECEIVERS. 1938. 58 p. N. Y. Institute of Radio Engineers, illus., 9 by 6 in., paper, $.50 each. These publications are revisions of the standards issued in 1933. They include the definitions, symbols, and methods of testing approved by the IRE.

VEKTORANALYSIS. (Sammlung Göschen 354.) By S. Valentiner. 5 ed. Berlin, Walter de Gruyter & Co., 1938. 136 p., illus., 6 by 4 in., cloth, 1.62 rm. A brief treatment of vector analysis, covering fundamental definitions, calculations and vectorial operations, uses in various physical fields, and a discussion of linear vector functions, tensions, etc.

WIRELESS DIRECTION FINDING. By R. Keen. 3 ed. enlarged. London, Iliffe & Sons, *Wireless World*, 1938. 803 p., illus., 9 by 6 in., cloth, 25s. A comprehensive manual on direction finding, dealing with wave propagation and direction finding theory in relation to modern ground, marine, and aircraft installations, including full descriptions of actual systems in use.

FLUORESCENCE and PHOSPHORESCENCE. By E. Hirschlaff. New York, Chemical Publishing Company, 1938. 130 pages, illustrated, 7 by 4 inches, cloth, $1.50. A brief monograph on the phenomena of fluorescence and phosphorescence as exhibited by the varying states of matter, with an examination of the present and possible future applications of these effects.

MECHANICS for ENGINEERING STUDENTS. By J. E. Younger. Scranton, Pa., International Textbook Company, 1938. 461 pages, illustrated, 9 by 5 inches, leather, $3.50. A text arranged for courses in analytic mechanics and designed to give only the necessary basic methods prerequisite for advanced engineering courses.

(The) MANAGEMENT of LABOR RELATIONS. By G. S. Watkins and P. A. Dodd. New York and London, McGraw-Hill Book Company, 1938. 780 pages, illustrated, 9 by 6 inches, cloth, $4.00. Considers the nature and development of personnel and labor relations, and the general functions of personnel management; psychological aspects of labor relations; technique of selection and placement, including job analysis and intelligence and ability tests; labor turnover, attendance problems, transfers and promotions, incentives, executive training, and health and disability problems; civil service personnel; employee representation, collective bargaining, and unions.

TOWARD FULL EMPLOYMENT. By H. S. Dennison, L. Filene, R. E. Flanders and M. E. Leeds. New York, McGraw-Hill Book Company (Whittlesey House), 1938. 297 pages, illustrated, 8 by 6 inches, cloth, $2.50. A consideration of the unemployment situation from the viewpoint of preventive measures to be applied in the early stages of business recession. A program is presented for the orderly provision of employment through a period of fluctuating conditions, and the necessary financial and taxation systems are discussed.

(The) ALLOYS of IRON and NICKEL. Volume 1. Special-Purpose Alloys. (Alloys of Iron Research Monograph Series). By J. S. Marsh; published for the Engineering Foundation by the McGraw-Hill Book Company, New York and London, 1938. 593 pages, illustrated, 9 by 6 inches, cloth, $6.00. This first volume, of two, is devoted to the constitution and properties of high-purity iron-nickel alloys and special-purpose alloys. The variations in physical, thermal, magnetic, mechanomagnetic, electric, and mechanical properties are described and examined with reference to the constitution of the alloy.

ALTERNATING-CURRENT CIRCUITS. By R. M. Kerchner and G. F. Corcoran. New York, John Wiley & Sons, 1938. 510 pages, illustrated, 9 by 6 inches, cloth, $4.75. Offers a modern approach to the subject of a-c theory and practice. In addition to the regular fundamentals of a-c circuits, there are included such specialized topics as: Energy measurements in polyphase circuits, electric filter theory, symmetrical components, and short-circuit calculations.

APPLICATION of TENSORS to the ANALYSIS of ROTATING ELECTRICAL MACHINERY. Parts I–XVI, Elementary Engineering Treatment. By G. Kron. Schenectady, N. Y., General Electric Company, 1938. 187 pages, illustrated, 11 by 8 inches, cloth, $4.50. This volume, which contains part of a serial that appeared in the *General Electric Review*, presents the tensorial method of analysis of standard types of rotating electrical machinery, and covers both transient and steady-state phenomena. The presentation aims to fill the usual needs of designers and application engineers.

Engineering Societies Library

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MAINTAINED as a public reference library of engineering and the allied sciences, this library is a co-operative activity of the national societies of civil, electrical, mechanical, and mining engineers.

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Many other services are obtainable and an inquiry to the director of the library will bring information concerning them.

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Papers Presented at Summer Convention, Washington, D. C., June 20–24, 1938

No.	Authors	Titles of Papers (Some Shortened)
☐ 37-58	Smith & Weygandt	*Double Line-to-Neutral Short Circuit of an Alternator
☐ 37-866	Appleman	*The Cause and Elimination of Noise in Small Motors
☐ 38-53	Calvert	†Amplitudes of the MMF Harmonics for Fractional Slot Windings
☐ 38-54	Porter	*Positive-Grid Characteristics of Triodes
☐ 38-55	Bewley	*Traveling Waves Initiated by Switching
☐ 38-56	Subcommittee Report	*Line-Type Lightning-Arrester Performance Data
☐ 38-58	Whitehead	*Lightning Protection of 22-Kv Substations
☐ 38-59	Poritsky	†Graphical Field-Plotting Methods in Engineering
☐ 38-60	Reagan	*A Self-Checking System of Supervisory Control
☐ 38-61	Race	*Tests on Oil-Impregnated Paper—III—Fluid Flow
☐ 38-62	Spurck & Strang	*A New Multibreak Interrupter for Fast-Clearing Breakers
☐ 38-64	Gulliksen	*A Position Regulator for Paper Slitters
☐ 38-65	Prince & Williams	*The Current-Limiting Power Fuse
☐ 38-67	Curry	The Co-ordination of Mathematics and Physics
☐ 38-68	Malti	Mathematics and Physics in Engineering
☐ 38-70	Brownlee & Dent	*Remote Control of Network Protectors
☐ 38-71	Bellaschi & Aggers	*Radio-Influence Characteristics of Electrical Apparatus
☐ 38-72	Cole	*Flashover Characteristics of Transformer Condenser Bushings
☐ 38-73	Terman	*Analysis and Design of Harmonic Generators
☐ 38-74	Schelkunoff	†Transmission Theory of Spherical Waves
☐ 38-75	Lyman & North	*Application of Large Phase-Shifting Transformer
☐ 38-76	Morgan	Co-ordination of Mathematics and Physics With EE Subjects
☐ 38-77	Inglis	*Transmission Features of the New Telephone Sets
☐ 38-78	Wahlquist & Taylor	*Noise Co-ordination of Rural Power and Telephone Systems
☐ 38-81	Jones	*Instruments for the New Telephone Sets
☐ 38-82	Teare	A Course to Develop Facility in Mathematics and Physics
☐ 38-83	Bryant	Co-ordination of Physics With Electrical Engineering
☐ 38-84	Sporn & St. Clair	*Tests and Performance of a High-Speed Multibreak Breaker
☐ 38-85	Dickinson	*"De-ion" Air Circuit Breakers
☐ 38-86	Sandin	*Enclosed Low-Voltage "De-ion" Breaker of High Capacity
☐ 38-87	Treanor	*The Wound-Core Distribution Transformer
☐ 38-88	Sorensen	†The Economic Status of the Engineer
☐ 38-90	Williams	*Combined Thyratron and Tachometer Control of Small Motors
☐ 38-91	Summers	*A Static Constant-Current Circuit
☐ 38-95	Pakala	*A Memory Attachment for Oscilloscopes
☐ 38-96	Kouwenhoven & Lotz	†Absolute Power Factor of Air Capacitors
☐ 38-97	Rusher & Mershon	*The Electric Strain Gauge
☐ 38-98	Concordia, Crary & Lyons	†Stability Characteristics of Turbine Generators

Papers Presented at Pacific Coast Convention, Portland, Ore., August 9–12, 1938

☐ 38-43	Lightning Arrester Subcom.	Testing and Application of Lightning Arresters
☐ 38-99	Monroe	†Electrification of the San Francisco-Oakland Bay Bridge Railway
☐ 38-100	Whelchel	Trends in Electrical Equipment in Hydraulic Power Plants
☐ 38-101	McMillan	Polarity Limits of the Sphere Gap
☐ 38-102	Smith	Use of Bismuth Bridge Magnetic Fluxmeter for A-C Fields
☐ 38-103	Shuck	A Variable-Register-Ratio Watt-Hour Meter
☐ 38-104	Thomson	Similitude of Critical Conditions in Ferroresonant Circuits
☐ 38-105	Morris	Application of Copper-Oxide Rectifiers
☐ 38-106	Wagner	Self-Excitation of Induction Motors
☐ 38-107	Ager	Determination of Induction-Motor Performance
☐ 38-108	Dalziel	Static Power Limits of Synchronous Machines
☐ 38-109	Peterson	General Operation of Transmission Line
☐ 38-110	Cozzens & Peterson	Corona Experience on Transmission Line
☐ 38-111	Cozzens	Insulation and Lightning Protection
☐ 38-112	Laughlin	Carrier-Current Equipment
☐ 38-113	Draper	Transmission-Line Relay Protection
☐ 38-114	Skellett	Narrow-Band Transmission System for Animated Line Images
☐ 38-115	Norwine	Controlling Amplitude Characteristics of Telephone Signals
☐ 38-116	Gaylord	The Pumping System of the Colorado River Aqueduct
☐ 38-117	Skilling	The Electrical Strength of Air at High Pressure
☐ 38-118	Pierce and Hamilton	Phase-Angle Control of System Interconnections
☐ 38-119	Lyon	The Electrostatic Unbalance of Transmission Lines

Papers Presented at Southern District Meeting, Miami, Fla., November 28–30, 1938

☐ 38-120	Rollman & Guice	Rural Line Protection Utilizing Co-ordinated Devices
☐ 38-121	Kuhn	Electrolysis and Corrosion of Underground Metallic Structures
☐ 38-123	Evans	Lightning Protection Improvements for Transmission Lines
☐ 38-124	Kirkwood	Grading the Engineer's Job
☐ 38-125	Almond	Electrical Design of Pickwick Landing Project
☐ 38-126	Jones	Mulsifyre System for Extinguishing Oil Fires
☐ 38-127	Housley	Reconditioning of Insulating Oils by Activated Alumina
☐ 38-128	Stratton & Stratton	Shop Practice in the Repair of High-Voltage Bushings
☐ 38-129	George & Bessesen	Generator Damper Windings at Wilson Dam

* These papers have been published in the TRANSACTIONS section of ELECTRICAL ENGINEERING.
† These papers have been published in the 1938 AIEE Transactions volume.